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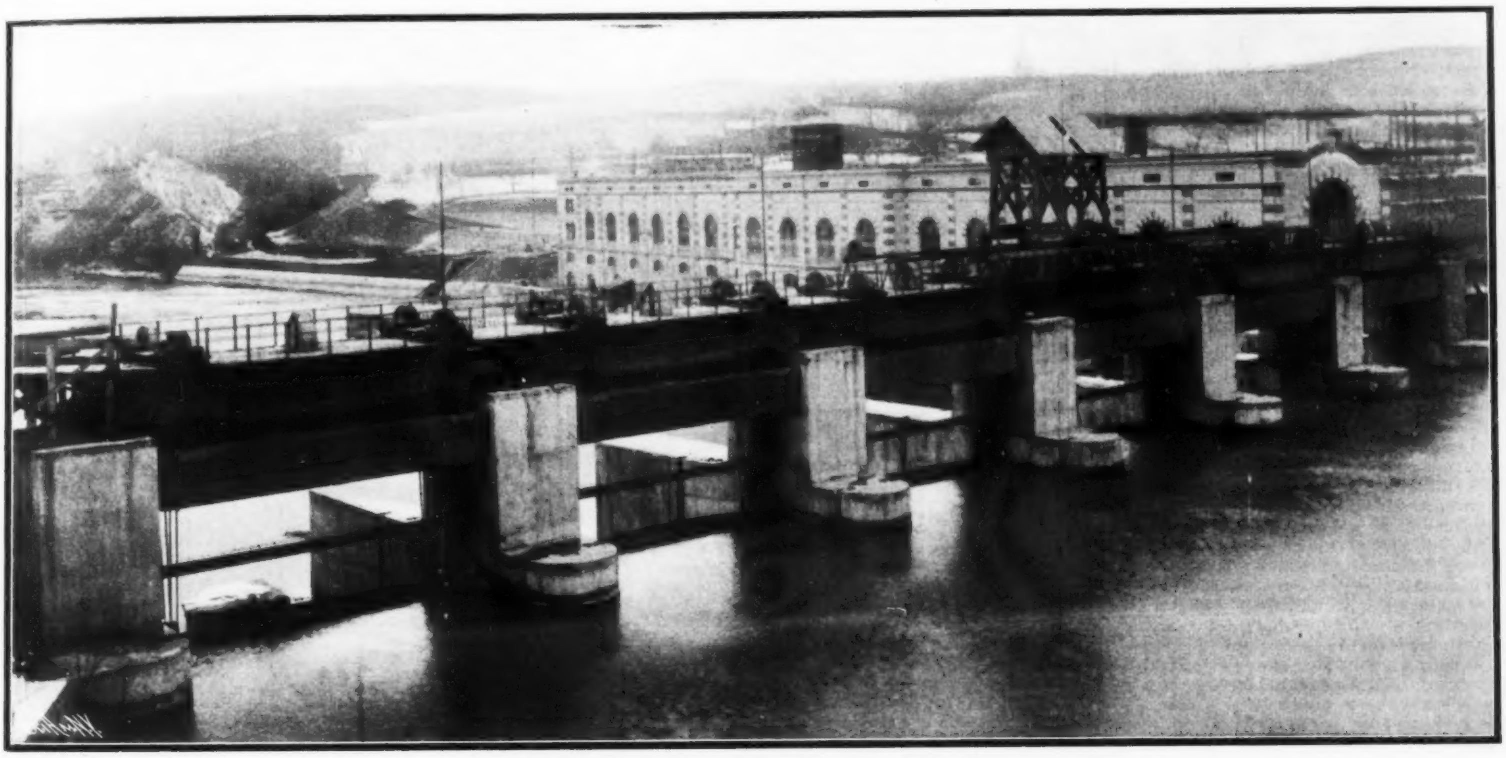
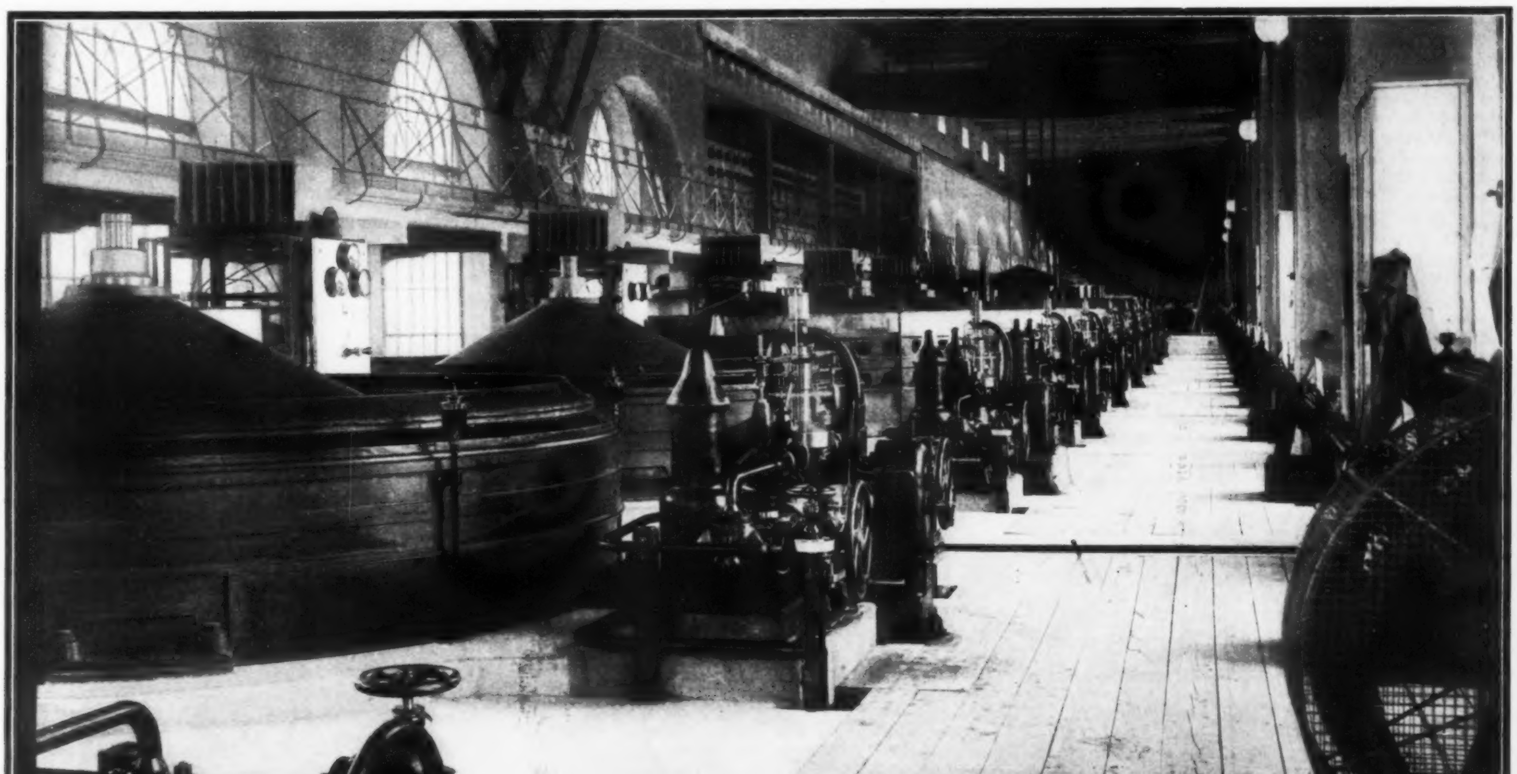


EXTERIOR OF THE CHÈVRES PLANT.



INTERIOR OF THE CHÈVRES PLANT.

LIGHT AND POWER PLANT FOR THE CITY OF GENEVA.

LIGHT AND POWER PLANT FOR THE CITY OF GENEVA.*

By the Paris Correspondent of the SCIENTIFIC AMERICAN.

ONE of the largest hydraulic plants in Europe is the station which was installed some months ago on the Rhone, near Geneva. The river, as it starts from Lake Leman, has a high velocity as well as a great volume, and is also remarkable for its deep blue color. It affords a considerable supply of power, and the city of Geneva has utilized this, first by erecting a large pumping plant across the river, in which a set of turbines furnish the city water supply, and more recently by constructing the large hydraulic plant of Chèvres, farther down the stream, which is designed to furnish all the current needed in the city for light and power, including the operation of the numerous tramway lines. A part of the current is also used in the surrounding district for large electrolytic works and various shops. The greater part of the electric plant was constructed on the Thury system by the Compagnie de l'Industrie Electrique, of Geneva, one of the largest of the Swiss electrical firms.

The illustrations show the general arrangement of the plant, which is laid out to use 20,000 horse-power. It contains fifteen generating sets of 1,200 horse-power each, which are mounted upon the turbine shafts. The dam, which measures 300 feet long, lies part way across the stream and is joined to one end of a station building 420 feet long and 50 feet wide. The water thus enters the station at the upper side, and, on coming out at the lower level, is directed to a point further down the stream by a long pier which starts from the dam.

As shown in the general view, the dam is about 300 feet long, and is made up of a series of seven piers, 55 feet long and 10 feet wide, which are supported upon a solid foundation of cement beton. The upper part, which continues the sliding socket for the gates, and which also acts as a support for the upper bridge, is 15 feet long. The piers are constructed of cement beton made with Portland cement in the lower part and Teil lime in the upper portion. To protect them against the action of gravel on the lower portions, the piers are covered with a plating of 1½-inch iron up to a certain height. The gates are moved up and down in grooves, and are composed of a flat body of plate iron from 0.5 to 0.7 inch thick, braced on the farther side by a series of 9 arc-shaped trusses. The opening between the piers is 32.5 feet. The gates move up and down against a set of rollers, which serve to press the edge against the guiding piece. These rollers are 21 inches long and 9 inches in diameter, and are mounted on an independent carriage.

The long bridge which passes across the piers serves to support the mechanism for operating the gates. The operating gear and handle is over the center of the gate, and on each side passes a shaft which operates a pair of sheaves at either end; over the sheaves pass the cables, which are connected to the top of the gate on each side.

The turbines for the Chèvres plant have been supplied by the well-known Swiss constructors, Escher, Wyss & Co., and were installed at two different periods, forming two distinct groups. The first five turbines were designed for a speed of 80 revolutions per minute, but when the remaining ten came to be installed, it was found advantageous to increase the speed to 120 revolutions. Owing to the great variations in the fall (28 feet in summer and 14 feet in winter) and as the speed is to be made as high as possible, while at the same time using large units of force equal to 800 or 1,200 horse-power, it was decided to install a type of double turbine in the Chèvres plant, superposing two separate turbines on the same vertical shaft.

During the winter season, corresponding to the period of high water with a fall of 28 feet, the lower turbine operates alone, but in times of low water, during the summer months, the two turbines operate together. The maximum power which is obtained from this turbine set is 1,200 horse-power. This double arrangement allows of obtaining a constant speed of 80 revolutions per minute under the varying conditions of the fall. The two turbines are of the conical reaction type, and each has three series of vanes; the water is introduced at the upper part. This construction makes it possible to obtain a relatively high speed in spite of the low fall of water, and also to use large sectional openings. The shaft is a massive steel one 12 inches in diameter, supported in four bearings. It carries the revolving part of the dynamo on its upper end, and above the dynamo it revolves in a special oil-pressure bearing. A circular movement can be given to the outer portion, by which a very prompt regulation is obtained with a small displacement of the orifices. Each of the two turbines is arranged in this way, and the regulator acts at the same time upon the three superposed portions of the outer wheel, and needs but a small movement to give a good speed regulation.

The ten turbines which were the last to be installed, were designed for higher speed, and they run at 120 revolutions per minute. These turbines are of a different design, and the water, instead of entering the revolving wheel from the exterior, in this case is brought into the interior. This new disposition allows of obtaining a much higher speed, as the old turbines give but 80 revolutions. Each group of turbines which drives one of the main dynamos is composed, like the former, of two complete turbines placed one above the other. During the winter, when the head of water is 28 feet, only the lower turbine is employed, but in the low water periods both turbines work together. Five of the new groups are specially arranged to work with the high fall, and are used during the winter, while the five other sets are built to operate in the summer months, and the two turbines are disposed so as to operate with a low fall of water. Under these conditions the turbines furnish from 850 to 1,200 horse-power at 120 revolutions. To support the weight of the revolving parts and thus diminish the friction on the lower bearing, a new method has been devised. The pressure of the descending water is allowed to form between two disk-shaped pieces fitted one on the shaft and one at the exterior, so that the counter-pressure which is established serves to balance the weight of the moving parts. This method has proved quite successful.

Each of the turbines is provided with a hydraulic regulator, which will be observed in the general view. A regulating mechanism is operated from the main shaft by belting and gears, and serves to control the action of a hydraulic motor. The latter is connected with the turbines by a system of transmission, and serves to regulate the admission of water. It comes into operation especially at the time of starting the machine, and acts first upon the lower series of apertures and then upon the upper, which follow automatically. The motor uses oil under a pressure of 15 atmospheres, which operates three pistons contained in separate cylinders. Besides the main turbines, there are three smaller turbines of 120 horse-power for the exciting dynamos, which make 150 revolutions per minute. The interior view of the station shows the main dynamos, the greater part of which have been furnished by the Compagnie de l'Industrie Electrique. The first five machines are alternators of the biphase type, and are built on the Thury system. These dynamos give a tension of 2,750 volts, and operate normally at 80 revolutions per minute, which gives them a frequency of 45 cycles per second. By connecting the two sections of the armature in series, the alternator will supply monophase current at a tension of 5,500 volts. The current needed to excite the fields of these machines is 45 amperes for the single field winding. The total weight of the exterior fixed portion of the machine is 77 tons, while the revolving field weighs 13 tons. The weight of the two turbines, together with the main shaft, is about 13 tons. As the vertical pressure of the water upon the turbines is estimated at 12 tons, the total load which is supported by the lower pivot of the shaft figures out at 38 tons. To support this heavy weight it was necessary to use a special form of pivot which is operated by oil pressure. It consists of two circular disks, placed one above the other, the upper disk being fixed to the lower end of the shaft and the second resting on the foundation socket. The lower plate has two annular grooves or chambers, which are connected by a line of piping to the system of oil-distribution under pressure which supplies the turbine regulators. The pressure exerted by the oil between the plates is sufficient to lift up the whole of the movable system, so that it rests upon a bed of oil and revolves with scarcely any friction. The oil which escapes is collected by other pipes, and a set of pumps returns it to the circulation.

The next six dynamos of the series are also 1,200 horse-power alternators, giving a tension of 5,500 or 2,700 volts and 45 cycles, working at 120 revolutions per minute. In this case the field circuit of the machine remains constant, and to give the two different tensions, the two armature windings are connected either in series or parallel. The armature is stationary and forms the exterior portion of the machine. The coils are placed in insulating tubes which pass through a series of holes along the inner periphery of a laminated ring. Inside the armature ring revolves the field, which is fixed to the turbine shaft and consists of a circular piece supported by a set of conical arms upon which is placed a set of 46 radial field poles. The next three machines, which were the last to be installed, will be noticed in the foreground of the interior view. These alternators also give 1,200 horse-power, and, like the former set, run at 80 revolutions per minute. They are biphase machines, and furnish 5,000 volts for each phase. The armature is stationary and forms the exterior ring, while inside it revolves a field made up of 46 pole-pieces fixed to a cast-steel hub which is placed on the shaft. The revolving part of these alternators has a maximum diameter of 23 feet and weighs 19.25 tons. Inside the exterior ring, which forms the armature, the coils are placed in a series of slots and are insulated with mica. The last machine in the series is a special direct-current dynamo that has been constructed on the Thury system to furnish a heavy current to the electrolytic works, which are situated on the bank of the Rhone near the Chèvres plant and belong to the Société la Volta. These machines give the same power as the others and operate at a like speed, but are specially designed to furnish a direct current of 4,000 amperes at 208 volts. The total weight of these machines is 67 tons.

At one end of the station is the set of three smaller turbines which drive the smaller dynamos for supplying current to the field magnets of the main alternators. These machines each deliver 750 amperes at 115 volts, working at 150 revolutions per minute. The armatures of these dynamos are mounted directly upon the turbine shafts, and are surrounded by an exterior field of six poles.

From the Chèvres plant the current is brought over a high-tension line to Geneva, where it is received in a large sub-station and transformed to a low-tension current for supplying the lighting and power circuits of the city.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

The date of the first telegram received in Chicago and of the first railway train to run over a track within its limits is 1848.

SUPERHEATED STEAM. A REVIEW OF ITS DEVELOPMENT AND USE.*

THE use of superheated steam is not new; on the contrary, it is probably not far from 75 years old. The old masters in steam engineering, without doubt, realized the fact that the principal loss of efficiency in the steam engine was due to the condensation of steam in the cylinders, and, as is well known, they tried a great many means to reduce it, and with varying degrees of success. There is no question in the minds of all competent authorities that the best means of reducing the condensation is in the use of highly superheated steam, and this has been known for a great many years. It almost seems that the "grand old man," James Watt, anticipated or at least had a presentiment of nearly all the improvements in the steam engine which were to be introduced into its design during the last century. However, it appears he had no knowledge of superheated steam or of its advantages, which seems very natural, as he really was the first one who had an adequate and thorough knowledge of saturated steam. The first mention of the practical use of superheated steam which I have been able to discover, is found in the "Life of Richard Trevethick" of the Binner-Downs Mine in Cornwall, England. In this book it is stated that a certain Capt. McGregor in 1828, in order to compete with a record established by an engine of a neighboring mine, whose cylinders had been insulated with sawdust, built a jacket of brick around the cylinder and the steam pipe, with an air space between the brick work and the iron, and that he built a fire in this open space, by which means he increased the duty of his engine from 41,000,000 to 63,000,000 foot-pounds per bushel (86 pounds) of coal. Trevethick himself tested the 70-inch cylinder engine with steam at 48 pounds pressure and which made 8 strokes per minute, and he found that by using 5 bushels of coal in 24 hours under the cylinder, he reduced the consumption of coal by the boiler from 108 to 67 bushels for the same work, showing a saving of more than 26 per cent. That such a saving must necessarily have aroused attention is evident; but it has been impossible for me to find any trace of it in the published records. In 1834 John Ericsson made some experiments with superheated steam, but no records of these experiments have been found. The next record that I have been able to find is that in 1845 Mr. Longridge made several experiments with superheated steam at low pressure, and in 1851, he was followed by Rafford in France, who took out patents for a superheating plant.

From this time on, and lasting, perhaps, for 20 years, the interest in superheated steam was very active. Among the many engineers and scientists who contributed to the progress in this line should be mentioned especially Hirn, Isherwood, and Faraday. The first named made a great many experiments in 1857, using steam of 55 pounds pressure and temperatures from 410 to 490 degrees Fahrenheit. The results of his accurate experiments showed an increase in the economy of the whole plant of from 20 to 27 per cent.

During the fifties and sixties, however, the principal use of superheated steam was found in the marine engine, and in the literature of the subject quite a number of tests of steamships with and without the use of superheated steam may be found. Penn showed an increase of economy of 20 per cent for the steamer "Valletta" with a steam pressure of 20 pounds. The Parson and Pilgrim's superheater was especially designed for marine practice. It consisted of a number of semicircular pipes placed in the furnace, by which means it is stated that a saving of one-third in fuel was realized. The English Board of Trade, however, objected to the use of superheated steam on the ground that the high temperatures used were liable to break the steam up into its elements, thereby making it unnecessarily dangerous. Fortunately, Prof. Faraday, who fully investigated the matter, was able to convince the authorities that this objection was unfounded. The tests of marine engines made at about the same time, during the latter part of the fifties, show gains in economy of from 20 to 30 per cent, always depending upon the amount of superheat which was available.

Our own Isherwood was at first very skeptical as to the practical use of superheated steam. He at first declared against it on the ground of injury to the cylinder, difficulty of lubrication, extra weight and short life on board of ship. Later on, however, he recommends the use of superheated steam because of the gain in economy of 30 per cent shown by his experiments, but suggests that the limit of superheat be placed at 100 deg. F., on account of the difficulties of lubrication. In 1863-4, he made extensive tests on the steamer "Eutaw" which had a single-cylinder inclined engine with poppet valves and a Stevens adjustable cut-off. The best results of these tests show a gain in steam economy of 18 per cent and 15 per cent in coal consumption.

During the years from 1850 to 1870 a great many superheaters were installed, especially on shipboard, notwithstanding the fact that engineers always found great difficulties with respect to the lubrication and that the material of the superheaters did not withstand the action of the heat for a very long time. That there was trouble with the lubrication should not surprise anyone when it is remembered that none of our present-day mineral oils were known at the time, and that the only available lubricating materials were animal oils and fats. The steam pressure used up to that time did not exceed 50 pounds, at least not on

* From paper by Prof. Storm Bull, Journal of the Western Society of Engineers, December, 1903.

shipboard, and for such a pressure the animal oils or tallow answered very well, even if the steam was superheated perhaps 100 deg. F. But the latter part of the sixties saw the introduction of the compound engine with its accompanying high pressure, and this proved to be a very effective damper to the use of superheated steam—and for two reasons. The first one was the very much greater economy of the compound engine as compared with the single-expansion engine using steam of low pressure, and because of this increased economy a saving of both space and weight, a very important factor in a ship. The second reason was that the difficulties in the way of proper lubrication of the cylinders became so great that it was found necessary to reduce the superheat to such an extent that the gain from it in economy became almost imaginary and this certainly did not warrant the expense of the installation of the superheater. The universal use of the compound engine on shipboard, therefore, very soon made the use of superheated steam impossible on steamships. It had been much less used in stationary practice, but with the gradually increasing pressure it also disappeared here. It is true enough that the use of mineral oils very soon after this time became general, but our present-day heavy lubricating cylinder oils were not known then and in addition—and this is much more important—the attention of all the foremost engineers of the world, working in this line, was now exclusively directed toward the improvement of the economy of the steam engine by means of the use of higher pressure and of the compound principle; they lost sight of the superheated steam, presumably, because of the many bad reports regarding its use. You are all aware of the fact that the improvement of the economy of the steam engine during the last thirty years of the last century was all due to the increasingly higher steam pressure and to the introduction of the compound and multiple expansion engines, if exception be made concerning the greatly improved mechanical details, especially, with respect to valve gear and governor. But toward the end of the last century nearly all competent engineers agreed that the improvement due to the causes just mentioned had about reached its limit. The increased cost of making more than a triple or quadruple engine was not warranted by the very slight increase in economy due to an additional cylinder—at least with the high stetm pressure then practicable. Because of the available material it had been impracticable—perhaps unprofitable—to design boilers for a higher pressure than, say, 250 pounds. It is due to this fact that the attention of the engineering world has within the last half dozen years increasingly been directed to the use of superheated steam as a means of improving the still lamentable low economy of the steam engine, and it is my opinion that the history of these years has conclusively shown that for the present, at least, the outlook in this direction is very much brighter than in any other.

RECENT DEVELOPMENTS IN SUPERHEATED STEAM.

In recent years the development of apparatus for superheated steam has been more marked abroad than here, and among its most prominent advocates have been Hirn, in Mulhouse, Schwoerer, his successor, and William Schmidt, in Germany, who was the first to use in practice highly superheated steam. You will doubtless remember the sensation that was created some eight years ago, when the results of tests on a boiler and engine constructed by William Schmidt were reported in the technical papers. Although the engine was quite a small one, yet it was shown that the consumption of steam was only about 10.4 pounds per indicated horse-power per hour, when using superheated steam. The statement of the consumption by an engine of a certain number of pounds of superheated steam per horse-power per hour does not give the means for a true comparison of the performance of this engine with one using saturated steam. It is much more equitable to base the comparison on the consumption of coal or the number of heat units converted into work. In the test spoken of it was shown that the amount of coal used per indicated horse-power per hour was only about 1.3 pounds, certainly an extraordinary result for an engine of only 75 horse-power. The engine in question was a tandem compound, both cylinders being single acting; of very original design throughout and built especially for the use of highly superheated steam. The boiler, which was also built and designed by Mr. Schmidt, was also very original and has since proved to be excellent in every way. As a result of this first test, Mr. Schmidt's engines became very popular and at the present time several hundred are running in Germany and adjacent countries.

As is well known there are two essentially different arrangements of the superheater with respect to the boiler. The most common is to install a coil in the boiler setting proper, through which the saturated steam taken from the top of the boiler is drawn on its way to the steam engine. If a high degree of superheat is wanted the coils must be installed in such a way that the hot gases will strike them long before they have been cooled sufficiently to allow them to escape into the chimney. This arrangement has, as is well known, been extensively employed by the Babcock & Wilcox Company. On the other hand, if only a slight superheat is desired the coils may be placed so that the gases on their way from the boiler to the chimney will surround the coils. This last arrangement is usually not satisfactory, as the degree of superheat is so small that the gain in economy of the steam engine frequently does not warrant the installation of the superheater.

The second arrangement is to install an independent superheater with separate furnace, and a great many installations of this kind are found at present, especially on the continent of Europe. Many competent engineers have expressed their doubts as to the possibility of a gain in economy due to such installations, but repeated tests of a number of such plants have shown that these doubts were not warranted by the facts.

Both wrought iron or steel and cast iron are used for superheaters. Because of the high temperature to which the material of the superheater will be raised, it is impracticable to have ordinary flange joints or couplings exposed to the hot gases. If therefore the superheater consists of a series of steel pipes of small diameter, they must be bent into coils, something like the ammonia pipes in a refrigerating machine. If, on the other hand, the superheater is built of cast iron, there are usually a number of large, straight cast-iron pipes connected by flanged return bends, the flanges being placed in such a manner that they cannot be reached by the hot gases, these pipes being also provided with a large number of external ribs so as to increase the heating surface.

The difficulties which were encountered years ago with respect to the wearing out of the superheaters have now been overcome, as can be readily seen from the fact that there are now in service superheaters which have been used continuously for eight years and without any important repairs. The number of plants now running in continental Europe is several thousand, of which several hundred are more than four years old.

It was also to be expected that the use of such high temperatures in the engine cylinder would create new difficulties, not alone with reference to the proper lubrication of the same, but also and perhaps still more so, with regard to the great expansion of the parts of the cylinder itself. But it can also be stated that all these difficulties have been overcome. Just as in the gas engine where the temperatures are very much higher, and where these difficulties have been overcome by the proper design of the cylinder, so in the steam engine our modern engineers have found the proper way to proportion the various parts of the cylinder in such a manner that the expansion due to the high temperature does neither produce breaks in the casting nor leaks at the stuffing boxes. With reference to the lubrication it is only necessary to refer to our modern heavy lubricating oils which made our modern gas engines possible. The latest type of engine designed for superheated steam does not look very different from an engine using saturated steam of very high pressure, although a good many details may be different. The experience of recent years is that Corliss valves are not adapted for the use of highly superheated steam and that consequently we will have to modify the design of our most economical engines in a very essential part before we can use with profit steam superheated to a degree which will show an improvement in economy to a degree that will warrant its use.

SUPERHEATED STEAM ENGINE TESTS.

The principal results of the test of Prof. Schroeter of the Schmidt engine and boiler in 1895 and mentioned before, were as follows:

Table I.

Size of Engine.—12¼ inches x 27 3-16 inches x 19½ inches; vertical, tandem, compound, making—

	1st Test.	2d Test.
Pressure	156.2	159.0
Brake horse-power	61.72	62.18
Superheat, degrees Fahrenheit	235.0	281.0
Steam in lbs., per I. H. P., per hour	10.91	10.19
Steam in lbs., per brake H. P., per hour	12.61	12.34
Coal in lbs., per I. H. P., per hour	1.36	1.26
Coal in lbs., per brake H. P., per hour	1.57	1.52
Per cent of heat accounted for in saturated steam	65.0	63.7
Per cent of heat in the superheat	6.9	8.2
Per cent of heat given to feed water	6.9	6.6
	78.8	78.5

In 1896 Prof. Ripper of England published the result of a series of tests of a small Schmidt engine using superheated steam. The size of the engine was 7 1-16 by 11¾; it made 180 revolutions per minute. He used both saturated steam and steam of different degrees of superheat in order to show the influence of the same.

TABLE II.

	1	2	3	4
Steam Pressure, Lbs. Absolute	87.5	79.9	87.6	116.0
Temperature of Steam, Deg. F.	329.0	412.0	667.0	653.0
Degrees of Superheat, F.	0.0	88.0	338.0	306.0
Indicated Horse Power	16.55	16.32	16.59	17.00
Lbs. of Steam per Hour per Indicated Horse Power	39.33	34.66	19.13	17.58

It will be apparent from this table how rapidly the consumption of steam decreases with the increase of the superheat. With 338 degrees of superheat the number of pounds of steam used is not quite one-half that used for saturated steam. In itself this performance of a single-expansion, non-condensing engine, indicating only some 18 horse-power and using less than 20 pounds of steam per horse-power hour is very startling.

A small Schmidt steam engine and boiler installed at Ascherieben, Germany, was tested by Prof. Schroeter. The cylinder had a diameter of 9⅞ inches and a stroke of 15¾ inches and was single acting; it made 150 revolutions per minute. A series of tests was made to show the influence of the cut-off and of various degrees of superheat. The most important results were as follows:

TABLE III.

	1	2	3	4	5
Cut-off Per Cent	16.1	22.9	35.0	41.1	48.0
Steam Pressure, by Gage	120.0	117.7	111.4	98.7	95.8
Temperature, Deg. F.	690.0	671.0	673.0	680.0	689.0
Superheat, Deg. F.	339.0	321.0	328.0	343.0	354.0
Consumption of Steam per Horse Power per Hour	17.85	17.59	18.03	17.54	18.03

The results show that the cut-off has very much less influence on the economy of the steam engine when running with superheated steam than with saturated, because there is very little change in economy between a cut-off of 16 per cent and one of 48 per cent, whereas it is probable that if the engine had been running with saturated steam this difference would probably have been at least 25 per cent. It is also well known that the interchange of heat between the steam and the cylinder walls is very rapidly reduced with increased superheat, so that, for instance, the heat absorbed by the walls during the admission period is almost zero when the steam is superheated from three to four hundred degrees. The gain in economy due to the use of superheated steam is not alone due to the greatly reduced condensation in the cylinder, but also and perhaps in just as high a degree, to the greatly reduced interchange of heat between the walls of the cylinder and the steam while it is in the superheated state, this being due to the absence of water, which is always adhering to the walls when saturated steam is being used. From a number of carefully conducted tests it has been shown that the steam at the end of the expansion in the high pressure cylinder of a compound engine is still slightly superheated, if the superheat to begin with is from 200 to 300 deg. F.

A month ago appeared a series of articles in the Zeitschrift des Vereins Deutscher Ingenieure by Prof. Schroeter, in which he gives the results of some remarkably interesting tests of a 250-horse-power compound steam engine, built and installed in Ghent, Belgium. The tests were made to determine the economy due to superheating the steam to various degrees and also to determine the influence of variation of load on the economy, using superheated steam. The results obtained from this engine are truly remarkable and in fact are so good that Prof. Schroeter says in the first article that the economy is higher than for any other engine of its size so far tested. A series of six tests with saturated steam and different loads was first made, then five tests with superheated steam, and for the same loads, with the exception of one, in which the engine was empty, and finally five tests were made for the same load but with different degrees of superheat.

The engine was a tandem compound, having poppet valves and ran condensing. The cylinders were 12¾ inches and 22 inches in diameter, the stroke being 32½ inches, and it made 127 revolutions per minute. The steam pressure was kept as nearly as possible equal to 145 pounds by the gage during all the tests. The main results are given in Table IV.

TABLE IV.

Number of Test	1	2	3	4	5	6 (empty)	7	8	9	10	11	12	13	14	15	16
Indicated Horse Power Developed	316	277	222	170	118	22	318	252	223	170	121	226	227	223	223	218
Degrees of Superheat	....	....	....	....	....	....	204.4	225.2	225.9	223.9	223.9	43.7	97.7	151.7	221.2	310.9
Consumption of Steam in Pounds per H. P. Indicated	13.43	12.64	12.08	11.48	11.84	13.52	10.71	10.25	9.83	9.59	9.50	11.58	11.00	10.67	9.81	8.89
Gain in Economy on the Basis of Actual Consumption of Steam	....	....	....	....	....	....	....	....	....	....	....	.04	.09	.12	.19	.26
Equivalent Consumption of Steam per H. P. Indicated	....	....	....	....	....	....	11.64	11.18	10.71	10.43	10.36	11.77	11.44	11.33	10.69	10.01
Gain in Economy due to Superheating, based upon Equivalent Consumption	....	....	....	....	....	....	.133	.121	.110	.104	.125	.024	.051	.060	.113	.174
Heat Units Required per I. H. P. per Hour	278	261	250	241	245	290	241	231	222	216	214	244	237	234	221	207

By equivalent consumption of steam is meant the reduction of the number of pounds of superheated steam used to the equivalent number of pounds of saturated steam of the same pressure, the reduction being made on the basis of heat units contained. The comparison of economy on this basis is consequently perfectly equitable. The results, as will be seen, are certainly startling, as I do not know of any engine of this size which has as high an economy whether running with saturated or superheated steam, the best results being 11.48 pounds for saturated and 10.01 (equivalent) for superheated steam. It is also shown in the article mentioned that in several of the tests the steam was still superheated, both at the end of admission and of expansion, confirming the general statements in this respect made before in this paper.

USE OF THE EARTH AS A RETURN CONDUCTOR IN CONNECTION WITH COMMERCIAL ELECTRICAL INSTALLATIONS.*

It seems truly remarkable that we should have waited sixty-six years after Steinheil (in 1838) discovered that the earth was capable of replacing a conductor in the transmission of an electric current, before thinking of utilizing the earth industrially as a return conductor for the transmission of currents in large quantities. The International Society of Electricians, of Paris, has now taken the matter in hand, and has not only induced all electricians to make known the results of their researches, but has itself made and is still making very interesting ones. It purposes to elucidate many questions, and it is especially seeking a method of preventing the well known disturbances that occur upon telegraphic and telephonic circuits. Another subject that the society has thought it worth while to consider is that of ground-plates, which should have a very slight resistance in order to prevent losses. Since, however, the resistance is variable with the oxidation of the plates, it would seem as though this could be kept down with difficulty. In reality, however, there need be little worry about this in the case of transmission at a very high tension—the only one of interest at present, at least in transmissions to a great distance. The loss that a variation of a few ohms in the resistance might occasion would be absolutely inappreciable in a current having a potential of several tens of thousands of volts. For similar reasons, the counter electromotive forces which the battery formed by the two ground plates may generate, need not be considered. What, on the contrary, should especially enlist our attention is the subject of disturbances upon telegraphic circuits and how to prevent them. The cases are numerous in which, aside from telegraphic communications, telephonic ones have been interrupted by terrestrial disturbances due to industrial currents. To give but a single example, we may mention the disturbances caused by the triphase current of the Lecco Chiavenna Soudrio electric railway of Italy (20,000 volts in the principal circuit and 3,000 in the service one), where one of the phases of the current is connected with the rails, and where it has become necessary to make a complete metallic circuit for the telegraphic lines, thus doing away with the return through the earth.

Let us examine the subject a little more closely. According to the experiments made by M. Guarini, the disturbance, other conditions being equal, is so much the less and perceptible at so much the smaller distance in proportion as the current is less intense. At the limit, with a current of very high tension and of very slight intensity, the effects are imperceptible, even in an extra-sensitive telephone. This is due to the fact that, because of the very high tension, the current becomes so diffused in the ground that it reduces its intensity beneath the limits at which it can prove prejudicial to the telegraphic and telephonic circuits. This means permits, therefore, of having a minimum and hence harmless density of current, through a very great diffusion.

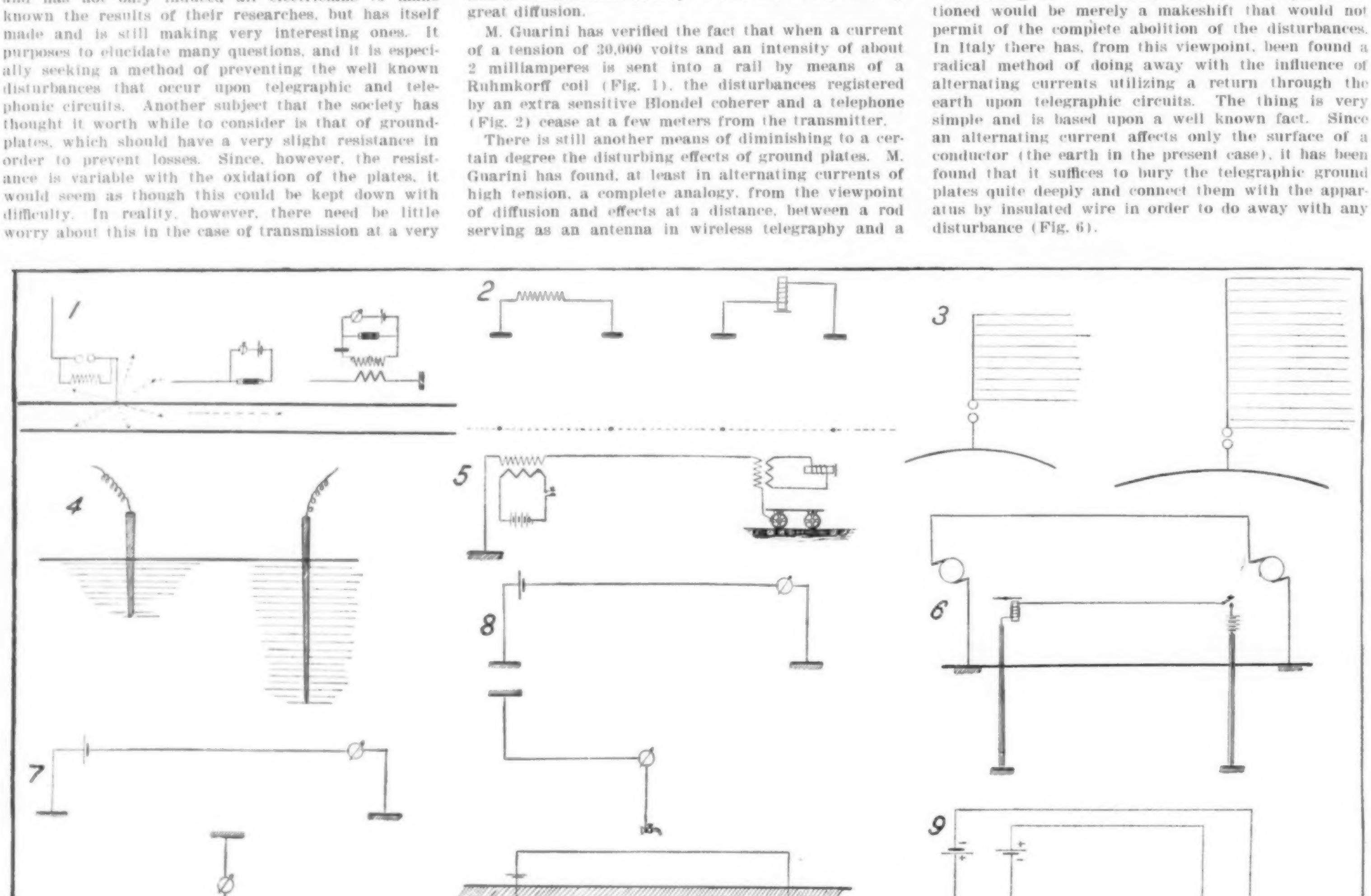
M. Guarini has verified the fact that when a current of a tension of 30,000 volts and an intensity of about 2 milliamperes is sent into a rail by means of a Ruhmkorff coil (Fig. 1), the disturbances registered by an extra sensitive Blondel coherer and a telephone (Fig. 2) cease at a few meters from the transmitter.

There is still another means of diminishing to a certain degree the disturbing effects of ground plates. M. Guarini has found, at least in alternating currents of high tension, a complete analogy, from the viewpoint of diffusion and effects at a distance, between a rod serving as an antenna in wireless telegraphy and a rod inserted perpendicularly into the ground. The longer a vertical antenna is, the more of an effective radius it possesses, perhaps because the zone concerned is greater. This zone is a cylinder the radius of which is indefinite and the height equal to that of the antenna (Fig. 3). So too, the deeper a rod is buried vertically in the ground, the more it diffuses the current in the latter (Fig. 4).

A rod inserted to a slight depth in the ground will constitute a poor collector, that is to say, one having a certain resistance, but will produce a slight diffusion and consequently a slight disturbance, in the same way that a short antenna in wireless telegraphy produces effects at relatively short distances. On the other hand, a rod inserted to a much greater depth constitutes a better collector, but, on account of its greater diffusion, produces more intense disturbances. Just here a question arises: Are good or bad ground collectors needed? M. Guarini answers at once that in the case in point—the transmission of energy to a great distance by a high-tension current—a bad ground collector suffices, because the resistance of a few ohms more or less is of no importance in a circuit of several tens of thousands of volts.

With a high-tension current M. Guarini has obtained good results (Fig. 5) by using as ground collectors the steel-tired wheels of a vehicle running over pavements. He is even of the opinion that in omnibuses without rails (Siemens & Halske or others) it might be possible to dispense with one of the wires and one of the trolleys, the return being made through the wheels and the pavement, in cases where use is made of a high-tension current sent directly to the vehicle. The use of high-tension current for the purpose, in view of the Zossen-Marienfeld experiments, would not be at all impossible.

According to M. Guarini, what we have just mentioned would be merely a makeshift that would not permit of the complete abolition of the disturbances. In Italy there has, from this viewpoint, been found a radical method of doing away with the influence of alternating currents utilizing a return through the earth upon telegraphic circuits. The thing is very simple and is based upon a well known fact. Since an alternating current affects only the surface of a conductor (the earth in the present case), it has been found that it suffices to bury the telegraphic ground plates quite deeply and connect them with the apparatus by insulated wire in order to do away with any disturbance (Fig. 6).



THE EARTH AS A RETURN CONDUCTOR IN COMMERCIAL INSTALLATIONS.

For continuous currents M. Guarini has experimented with an arrangement that seems to be just as simple. It is based upon the principle that if two equal and contrary forces be applied at one point, the resultant will be null. M. Guarini gives two equal charges of contrary polarity where there is a ground plate; and the results upon the receivers, however sensitive they may be, is null. The following is the series of experiments that he made:

(1) He connected a battery of accumulators of 16 volts and 2 amperes in circuit with two ground plates about 10 feet apart, and afterward connected a Hartmann & Braun galvanometer (resistance 6 ohms and sensitiveness per degree of deviation about 4 millionths of an ampere) with the cock of a water conduit on the one hand and on the other a ground plate, which he shifted to different places. When this plate was at an equal distance from the two others (Fig. 7) and was consequently submitted to two equal charges of contrary polarity, the galvanometer marked zero, while previously it deviated more or less strongly, according to its proximity to one of the plates (Fig. 8).

(2) With 6 plates (Fig. 9) the experimenter formed two equilateral triangles with sides 20 centimeters

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

(7.87 inches) in length. In each triangle, one plate served to complete the circuit of the galvanometer and the two others to complete two circuits, including accumulators, furnishing 16 volts and 9 amperes. In each triangle, one apex was connected with the positive pole of a battery and the other with the negative. The deviation of the galvanometer was null, and was also inappreciable when the plates that completed the circuit of the galvanometer were situated at a distance that was very great as compared with that which separated the two ground plates.

A certain analogy will be found with the arrangement just described and the three-wire system commonly employed. The earth corresponds to the neutral wire, which is done away with. As may be seen, this arrangement, which according to M. Guarini would present no practical difficulties, seems to be capable of radically solving the problem of the complete abolition of disturbances due to ground plates. In order that the arrangement may prove efficacious it is necessary that the intensity of the current shall be the same in both circuits. It would be necessary to have a constant intensity system (Thury) of distribution, or, better still, a system of constant intensity and tension. In the latter case the solution recommended by M. Guarini would be to employ at the receiving station some batteries of accumulators to supply consumers (Fig. 10).

(3) M. Guarini being desirous of verifying on a small scale what takes place in tramways, formed a circuit with an overhead wire and a wire buried in the ground (Fig. 11). The galvanometer behaved as if it was in a shunt circuit of the main wire, to the resistance of which shunt circuit and of the galvanometer was added the resistance of the stratum of earth that separated the two ground plates of the galvanometer wire from the main wire. This experiment demonstrates that in a transmission in which the rails are utilized as a return, the disturbances upon a telegraphic or telephonic circuit are so much the less intense in proportion as the rails are more conductive, and the telegraphic or telephonic circuit, including the earth that separates the ground plates from the rails, are more resistant.

(4) The experimenter next formed a circuit (Fig. 12) double that of the preceding experiment and in which the whole was arranged as in the experiment with two conductors. The two buried wires were very close together. When the intensity of the current, which had been raised to 15 amperes, was the same in both circuits, the deviation of the galvanometer was null whatever was the position of the ground plates of the galvanometer, and on condition, of course, that the distance between the two buried wires was relatively great with respect to that which separated the overhead ones. It results from this experiment that, in the case of a double-track electric tramway, the disturbances upon the telegraphic and telephonic lines can be entirely abolished if each rail has a current flowing through it in an opposite direction to that flowing in the rail adjoining.

(5) As a last experiment, M. Guarini connected an accumulator in circuit with two buried wires, whose ends were joined together, when the same conditions as in the preceding experiment prevailed, the deviation of the galvanometer being null.

This experiment, according to M. Guarini, proves that if a time should ever come when the old system of electric traction of Siemens & Halske (in which the rails act as conductors for the flow of the current in both directions) should be improved in such a way that the losses would be inappreciable, this system would have the great advantage of not producing any disturbances in telegraphic and telephonic circuits.

From these experiments as a whole, in which the means employed for abolishing the disturbing effects in the earth are the same as those used for preventing the effect of induction in the air (double conductor), and from the experiments which M. Guarini hopes to try on a larger scale, he thinks he is warranted in concluding that it will yet be possible to employ the earth as a return conductor, thus doing away with half of the line (which is always costly), without any fear of disturbance in the circuits using weak currents, such as telegraph and telephone lines that use the earth as a return conductor.

A MACHINE FOR THE MEASUREMENT OF SCREW-THREADS.*

By the ENGLISH CORRESPONDENT of the SCIENTIFIC AMERICAN.

A MACHINE for measuring screw-threads has been installed at the National Physical Laboratory of Great Britain. It has been specially designed and constructed for the purposes of the Small Screw Gage Committee of the British Association, by the Cambridge Scientific Instrument Company, Ltd., of Cambridge. The machine, which possesses several interesting features, is intended for micrometrically testing the accuracy of commercially-produced screw-threads and taps.

The scope of the machine is normally confined to the measuring of screw-threads up to a maximum of ¼ inch outside diameter. By an arrangement of special chucks, however, screw-threads up to ½ inch outside diameter can be measured.

The elements which can be directly measured for any given screw-thread or tap are:

(1) External diameter.

(2) Diameter at root of thread.

(3) Pitch; to which is added in the case of V-threads—

(4) "Effective diameter:" that is to say, the mean diameter of the slant surface of the thread.

(5) Inclination of the side of V.

Furthermore, by means of this device, it is possible to detect and also to examine the numerous inequalities to which screw-threads are liable; that is to say, such irregularities of the thread as those concerning pitch, external diameter variation, and depth.

The most prominent feature of the instrument is the microscope through which the screw-thread is examined.

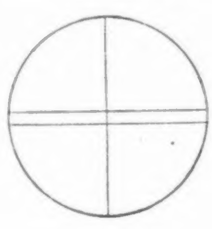


FIG. 1.

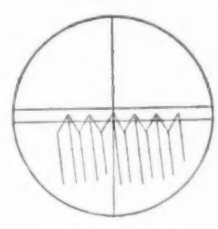


FIG. 2.

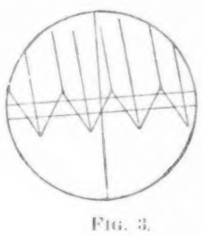


FIG. 3.

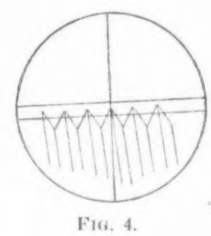


FIG. 4.

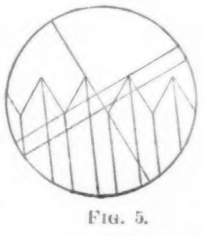


FIG. 5.

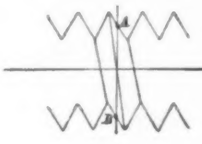


FIG. 6.

SCREW-MEASURING MACHINE.

This is fixed, but it can be set over to right or left, and the extent of the inclination, which should be equal to the mean rake of the thread under examination, is read by means of an arc divided in half degrees. The focusing adjustment of the microscope can be read micrometrically, the use of this reading being as follows: First of all, the microscope is so focused that it is possible to see the uppermost part of the thread in focus in the middle of the field. When the outside diameter of the thread is measured, this diameter is halved, then multiplied by the secant of the angle through which the microscope is set over. The result of this is the amount by which the microscope must be focused down, in order to obtain a correct sight of the profile of the thread. Cross-wires running at right angles in the manner shown in Fig. 1 intersect the field of the microscope.

The screw which it is intended to examine is held in position in a self-centering split chuck, the instrument being replete with a set of these, sufficient to carry all sizes of the screws coinciding with the range of capacity of the machine. The chuck is carried at the end of a cylindrical spindle which is supported in adjustable "V's."

The adjustments of these latter are such that they enable the axis of the spindle to be set absolutely true. Use is also made of the movements permissible by this mounting of the spindle. For instance, it is possible to bring any requisite part of the length in a screw within range. Also, by simply turning the spindle about its axis, a variety of various profiles of the screw as desired may be brought under observation.

This chuck spindle is turned or traversed by the operation of a milled head. The angles through which the spindle is turned are indicated. The outer surface of the milled head is divided, in the same manner as a dial, into 72 divisions, each of five degrees. A pointer of a somewhat triangular form serves the function of reading mark. This pointer is delicately pivoted, and through the greater part of its weight being placed below the center of gravity, is maintained by this agency in an upright position. This enables the degree of accuracy to be as near absolute accuracy as is necessary in the readings for which it serves.

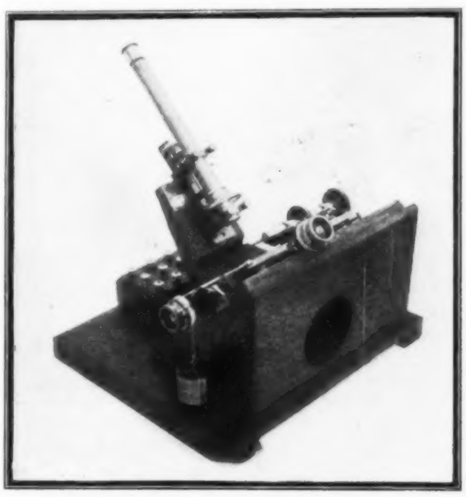
There are also two slow motions with micrometer readings, the object of which is to enable the screw-thread, in course of testing, to be set in a favorable position for examination. One motion is such that the screw under test can receive accurately gaged displacements in a direction perpendicular to its axis, i. e., to and from the observer. The micrometer head, which enables these displacements to be effected and read, projects above the inclined base of the instrument seen in our illustrations. There is also a short scale, which registers whole turns of the micrometer head. A range of movement of 15 millimeters is provided, the micrometer screw being of one-half millimeter pitch. The head of the screw is divided into fifty parts, so the readings can be correctly taken to 0.01 millimeter.

Figs. 2 and 3 show respectively the two settings by which the external diameter of the screw-thread is determined. In these diagrams are demonstrated the relative position of the screw-thread and the cross wires in the field of the microscope. The difference between these micrometer readings, corresponding to these two settings, is the required diameter of the screw-thread.

Adjustment is also provided for a micrometer traverse from right to left, or *vice versa*, of the screw-thread under examination. This is effected by the manipulation of another micrometer screw and head. When it is desired to measure the pitch of the screw-thread, the latter is set in the manner shown in Fig. 4. It will be noticed that in this case the intersection of the cross lines on the field of the microscope coincides with a slant side of the thread. The screw is then traversed in a direction parallel to its axis, until the intersection of the cross lines coincides with the corresponding slant side of the next turn of the thread. The difference of the two readings carried out in this manner supplies a value for the pitch. Furthermore, any irregularity in the uniformity of the pitch can be easily and instantly detected and measured, by simply extending the examination of the pitch to various points of the length and circumference of the thread.

The setting of the microscope for the measurement of the angle of a "V" thread is illustrated in Fig. 5. In this instance it will be observed that the cross wires of the microscope field are set parallel to the angle of the thread. For the purpose of these angle observations, the microscope is so mounted that it may, together with the field cross-wires, be revolved about its axis. The inclination to their mean position of the cross-wires is read directly on a beveled divided circle fixed near the objective end of the microscope. This diagram also illustrates an alternative method, by which the pitch of the screw-thread may be ascertained. The line *A B* in Fig. 6 illustrates the method for ascertaining the effective diameter of an angular thread. The settings are identical with those for ascertaining the pitch.

An important feature of the instrument is that the carriage for the two micrometer readings, the motions of which are similar to the traversing and surface movements of an ordinary slide rest, is supported upon one piece instead of two. That is to say, the upper and lower members rest upon the same plate, instead of the latter member carrying the former. This support is of cast iron, and has six facings, three for each member, though all are scraped to the same surface. The slides are designed upon a strictly geometrical basis, the advantage derived from which is that all possibility of any movement is absolutely obviated. Furthermore, back lash is overcome entirely by the application of sufficient loads to the slides, so that there is always the tendency to thrust in one direction against the operating micrometer screws. The instrument is very compact, only occupying a small space.



FRONT OF THE SCREW-MEASURING MACHINE.

REAR OF THE SCREW-MEASURING MACHINE.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

SHELL ORNAMENTS FROM KENTUCKY AND MEXICO.*

By W. H. HOLMES.

AMONG the many interesting relics obtained from mounds and burial places in the Mississippi Valley are the engraved shell gorgets, a number of which are now preserved in our museums. The most recent addition to this class of objects was obtained by the National Museum from Mr. C. A. Nelson, of Eddyville, Lyon County, Kentucky, and comes from a burial place encountered in opening a stone-quarry near Eddyville. It is a symmetric saucer-shaped gorget (Fig. 1) five inches in diameter and made apparently from the expanded lip of a conch shell (*Busycon perversum*). It is unusually well preserved, both faces retaining something of the original high polish of the ornament. Two perforations placed near the margin served as a means of suspension. The back or convex side is quite plain, while the face is occupied by the engraving of a human figure which extends entirely across the disk. It will be seen by reference to the illustration that this figure is practically identical in many respects with others already published.† It is executed in firmly incised lines and is partially inclosed by a border of nine concentric lines. The position of the figure is that of a discus thrower. The right hand holds a discoidal object, the arm being thrown back as if in the act of casting the disk. The left hand extends outward to the margin of the shell and firmly grasps a wand-like object having plumes attached at the upper end, the lower end being peculiarly marked, and bent inward across the border lines. The face is turned to the left; the right knee is bent and rests on the ground, while the left foot is set forward as it would be in the act of casting the disk. The features are boldly outlined; the eye is diamond shaped, as is usual in the delineations of this character in the mound region. A crest or crown representing the hair surmounts the head; the lower lobe of the ear contains a disk from which falls a long pendant ornament, and three lines representing paint or tattoo marks extend across the cheek from the ear to the mouth. A bead necklace hangs down over the chest and the legs and arms have encircling ornaments. The lower part of the body is covered with an apron-like garment attached to the waistband, and over this hangs what appears to be a pouch with pendent ornaments. The moccasins are of the usual Indian type and are well delineated. A study of this figure strongly suggests the idea that it must represent a disk thrower engaged, possibly, in playing the well-known game of chungkee.

Reference has occasionally been made to more or less well-defined analogies existing between the shell gorget engravings of the Mississippi Valley and similar designs from Mexican engraved gorgets and others occurring in various ancient manuscript books. The resemblances are indeed striking and deserve the attention of archeologists. In Fig. 2 is presented an engraved gorget obtained in Mexico, probably in the State of Guerrero, and now owned by the Field Columbian Museum, Chicago, which will serve to illustrate the resemblances and the differences in the delineations of the two regions. The discoidal gorget is the most common form in both Mexico and the United States; but this specimen is oblong, being wide above and narrow below, conforming in a measure to the tapering form of the lip of the shell from which it was carved. The gorget is rather roughly worked out and the upper margin has been perforated for suspension, but two of the perforations have been broken away.

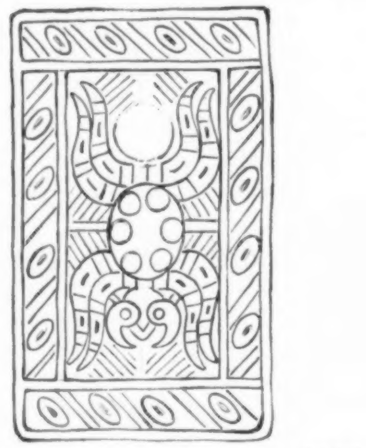


FIG. 3.—SPIDER ENGRAVED ON A BARK TABLET FROM AN ANCIENT GRAVE NEAR FLORENCE, ALABAMA. (LENGTH, 5½ INCHES.)

These perforations are in the plain border which surrounds the design, but there are seven additional holes within the engraved surface; these may also have served for attaching the ornament to a garment. The human figure, engraved in rather crudely executed lines, faces to the left; the right knee is bent as in the Kentucky specimen, and the left leg extends forward. The position of the arms is not readily made out, owing to the cramped position imposed by the contracted space. What appears to be the left hand, supplied with an enormous thumb, rests against the right border of the design and grasps some kind of an implement pointed downward. The right hand extends in front of the figure against the left border and is partly broken away; it appears to have grasped a staff terminating in what may be a rattle or possibly a symbolic device such as is often seen in ancient Mexican drawings. The mask-like features of the personage are drawn with the usual boldness of the Mexican work, and the eye is a conical depression surrounded by a curved line the ends of which open backward. The lower part of the face is covered with several groups of straight lines and a row of large teeth is shown. The ear and the ear disk are almost identical with corresponding features of the Kentucky specimen already shown. The somewhat elaborate headdress is well engraved, and the body and legs are covered with markings representing costume. At the waist there is a belt, and the legs show encircling ornaments and indentations suggesting buttons. The devices occupying the space beneath the human figure are carefully drawn but are so crowded together as to make interpretation difficult.

These objects are presented here not that any discussion is to be based upon them but rather for the convenience of students engaged in comparative studies of the native art of the various regions. A comparison of these with two other recently-described specimens will prove interesting.*

It may not be amiss to present in this place a somewhat remarkable design engraved on a thin piece of dark wood or bark which is about three and one-half inches in width and five and one-half inches in length (Fig. 3). It was obtained from "a mound seven miles inland, opposite Sheffield, Alabama," and belongs to a collection obtained by the Field Columbian Museum from Mr. C. W. Riggs. The excellent state of preservation shown by this fragile specimen is due to association with objects of copper. The design includes a border three-fourths of an inch in width filled in with obliquely-placed oval figures with central depressions, alternating with obliquely-placed straight lines—the whole combination suggesting a current scroll. Within this border is the boldly-drawn figure of a giant spider, the spaces on the ground being filled in with incised lines running at various angles. The treatment of the insect is highly conventional, but the character is well preserved. The resemblance of this example to certain delineations of spiders engraved on shell gorgets found in various parts of the same general region is very marked.

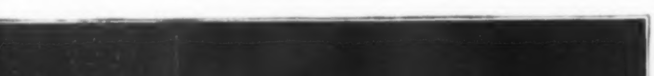


FIG. 1.—SHELL GORGET WITH ENGRAVED FIGURE OF A DISCUS THROWER, FROM AN ANCIENT GRAVE NEAR EDDYVILLE, KENTUCKY. (DIAMETER, 5 INCHES.)

FIG. 2.—SHELL GORGET FROM MEXICO WITH ENGRAVED HUMAN FIGURE. (LENGTH, 6½ INCHES.)

* Smithsonian Miscellaneous Publications.

† Holmes in Second Annual Report Bureau of Ethnology, pl. lxxiii.

* M. H. Saville: "A Shell Gorget from Huastecs, Mexico"; Bulletin American Museum, vol. xiii, p. 99. F. Starr, "A Shell Gorget from Mexico"; Proceedings Davenport Academy, vol. vi, p. 173.

IMPROVED METHODS OF PRODUCING COLOR VALUES FOR MONOCHROME AND THREE-COLOR PRINTING.†

By JOHN CARBUTT.

IN bringing to the notice of the members of the Franklin Institute improved methods of producing color values for monochrome and three-color printing we will first briefly trace the origin and growth of what is now recognized, from the scientific and commercial standpoints, as one of the most wonderful achievements in photography.

In 1861 James Clerk-Maxwell first experimented with three-color photography, and the color curves plotted by him are the base on which the results of to-day are obtained. But at that date there were no color-sensitive plates to be had, and the subject lay in abeyance until the late Dr. Herman Vogel, of Berlin, in 1873 found by the addition of certain dyes to collodion (principally

† Read before the Franklin Institute.

of the eosine group) a better rendering of the greens and yellows was obtained. Capt. Waterhouse also experimented on the same lines. In 1878-9 Mr. F. E. Ives produced very red sensitive collodion plates by the use of chlorophyl as a sensitizer. The late Mr. Carey Lea also made extensive experiments with salts of chlorine to produce color values, but, owing to the slowness of collodion and the long exposure required to reproduce the red, the securing of color values by photography was only made possible on the advent of the more sensitive gelatine dry plates. In 1883 Tailfer and Clayton, of Paris, brought out a dry gelatine plate color-sensitized with eosine, and the same was introduced commercially in London in 1884 by Mr. J. B. Edwards. Learning of this through the British photographic journals, I took up the study of the subject, and in 1885 commenced the manufacture of orthochromatic plates. These plates, with the aid of a yellow screen for landscapes, flowers, etc., and an orange screen for copying paintings, produce satisfactory color values, including blue, green, yellow and orange, but lack the power to reproduce red, unless a very dark red filter is used, entailing a very protracted exposure.

It is a little over two years since I commenced experimenting to produce a color-sensitive plate that would be sensitive normally to all colors of the spectrum. I found little difficulty in preparing a plate well sensitive to orange and red, but the spectrum test showed lack of sensitiveness to the blue green, and it took a great many experiments and combinations of dyes to overcome lack of sensitiveness in the line "F" of the spectrum, and which I finally achieved, as will be shown on the screen later. This plate I named "Polychromatic," as it is sensitive to all colors of the spectrum—from blue to red. Then came the necessity of suitable light filters to use with the polychromatic plate, so as to produce the Clerk-Maxwell color curve on the three respective negatives, from which three positives—either by contact with a medium rapid dry plate or in the camera, and the final negatives taken through the ruled line screens of Levy's (usually by the wet collodion process)—are made. And from these negatives the three half-tone copper plates are produced. Now while the Clerk-Maxwell method is quite correct in theory, the practical three-color workers find it too exacting to produce printing plates requiring little or no re-etching; consequently they (the etchers) prefer a more distinct separating of the color values than an overlapping curve, as will be seen in the spectrum image taken through three-color filters on the polychromatic plate. To meet this requirement I am making color-sensitive plates in two series, "C" and "D." The C plate is strongly red sensitive with green subdued, while the D plate is strongly green sensitive with red, orange and yellow subdued. The advantage is that a much lighter red filter can be used with the C plate to secure the red for blue printing plate, and a lighter green with the D plate for the red printing plate, and time of exposure reduced with both, while the C plate can be used with the violet blue filter for yellow printing plate, and as some three-color printers prefer a trace of red in the yellow plate, the C plate and a violet blue filter accomplish this. Besides the method here outlined, which requires the use of nine plates, a more direct method is now being practised, both in Europe and America, both with collodion and gelatine plates, by what is called "the direct method;" that is, the exposure is made through the light filters and the ruled screen, producing at one operation, when carefully carried out, the results obtained with three original negatives, then three positives and the final wet-plate negative through the ruled screen.

Three-color photography is now of wide application, both in the reproduction of works of art and manufactured articles. American three-color printers are in no way behind in their productions in comparison with foreign three-color printers. Philadelphia has several such establishments. A few examples of their work I have brought for your inspection.

HERRING OIL.*

By CHARLES H. STEVENSON.

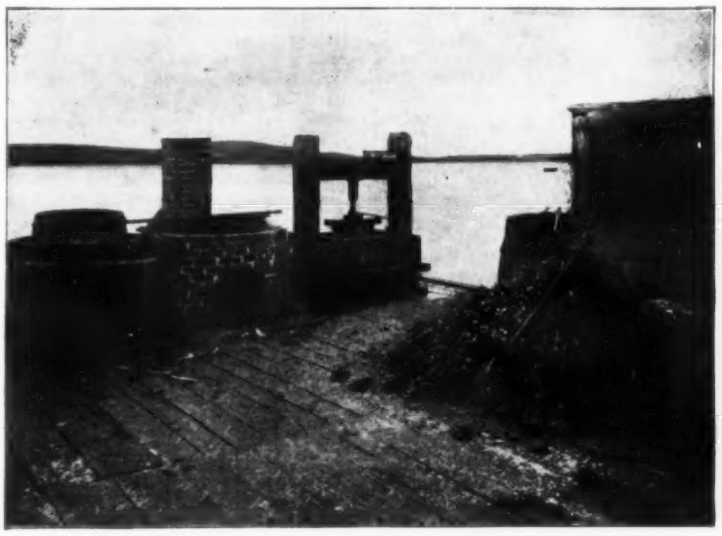
THE herring, including its related species—the sardine, pilchard, sprat, anchovy, etc.—is probably the most valuable and important product of the world's fisheries, not so much on account of the choice nutritive qualities, perhaps, as because of the enormous quantities obtained. When the product exceeds the demands of the food markets, including those required for salting, canning, etc., these fish furnish excellent material for oil production. Their utilization for this purpose is by no means of recent origin, the production of herring oil in the Bohuslan fisheries of Sweden over a century ago ranging between 1,000,000 and 2,000,000 gallons annually. Nor is it of limited geographical distribution, as the oil is produced to a greater or less extent in nearly every maritime country of Europe, in the British North American provinces, on the northern coast of the United States, in Japan, certain parts of the African coast, etc.

Since only the surplus of waste fish is used in oil making, and as the catch fluctuates greatly, it follows that much variation occurs from year to year in the quantity produced. The figures showing the output in a certain territory are quite unreliable for any year except the one to which they particularly relate. It is therefore difficult to approximate the product of herring oil throughout the world. It seems probable, however, that a reliable estimate would place the average annual yield at not far from 3,500,000 gallons, of which only a small portion is produced in the United States.

* United States Fish Commission Report of 1902.

During the fifteen or twenty years preceding 1875, when fish oils were worth about double their present values, there were small plants all along the eastern coast of Maine for utilizing the herring in oil manufacture. The crude material consisted principally of refuse fish taken in connection with the smoked-herring business, especially the small fish which otherwise were valueless. Sometimes the larger herring—over 6 inches in length—were utilized, but only when the comparative prices of oil and smoked fish warranted. This oil is usually quite clear, and the foots extracted in refining are nearly as white as spermaceti and sell for about 1 cent per pound less than tallow from sheep and oxen, being used largely by soap makers on the coast.

When the herring are taken in the fisheries of Europe in such quantities that they cannot be profitably used for food, it is customary to convert them into oil and fertilizer. Herring oil is extensively manufactured in Norway and Sweden, and with the exception of that obtained from cod livers, it is now the principal fish oil of those countries. The manufacture in Sweden developed rapidly eight or ten years ago, due to the abundance and consequent cheapness of herring. According to Capt. J. W. Collins, the number of factories increased from 3 in 1891 to 22 in 1895, the output in the season of 1895-96 amounting to about 500,000 gallons of oil and 16,000 tons of fertilizer. The scarcity and consequent high price of herring since 1896 have greatly restricted the output of these factories.



PRIMITIVE FORM OF KETTLE AND PRESS FOR RENDERING OIL FROM HERRING ON THE MAINE COAST.

This business did not engage the attention of large establishments, but was conducted by many fishermen in a small way, each man working for himself.

As the refuse herring accumulated they were sprinkled with salt, using about 1 bushel to 3 or 4 barrels of fish. After remaining in the salt about 24 hours, they were boiled in open kettles and then subjected to pressure in a screw press with capacity for about 1½ barrels. The average yield was about 16 gallons of oil to the ton of fish, but at times the fish were so fat that 20 and even 25 gallons were secured to each ton. The chum or scrap was partly dried and then sold as fertilizer at about $12 per ton.

The development of the sardine business furnished more profitable use for small herring, and since 1875 the waste from the sardine canneries has provided most of the material for herring-oil production in Maine. This waste consists of the spoiled fish and of the heads and viscera of fish used in canning, each factory generally using its own refuse. The extent of the business is small. The total output in 1889 amounted to 34,316 gallons of oil, valued at $8,580, and 1,941 tons of scrap, worth $15,528. Owing to the decreased value of the oil, this business has since fallen off considerably, the output in 1898 amounting to only 12,672 gallons of oil, worth $2,116, and 785 tons of scrap, worth $5,910.

The method of manufacture is described by Mr. Ansley Hall on page 479 of Report of United States Fish Commission for 1896.

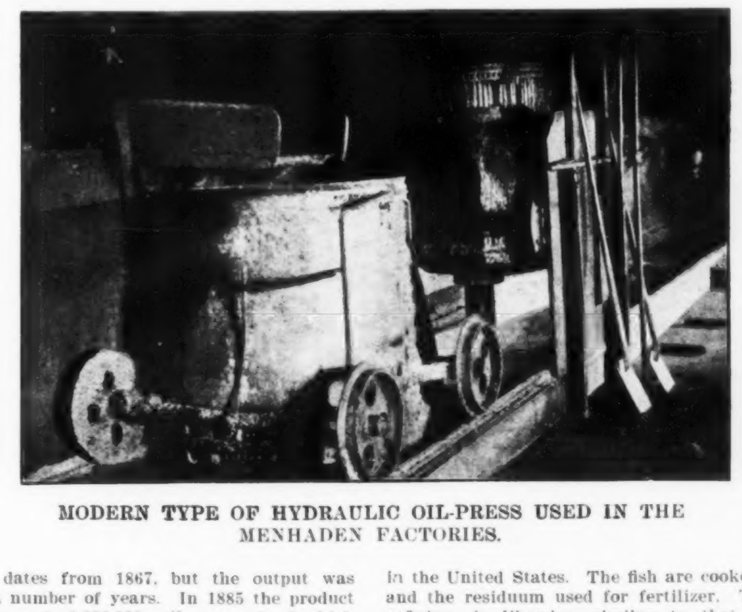
Considerable quantities of oil have been prepared from herring on the Pacific coast of the United States. The industry dates from 1867, but the output was irregular for a number of years. In 1885 the product amounted to upward of 200,000 gallons, much of which is alleged to have been sold as whale oil. In 1892, according to the Oil, Paint, and Drug Reporter, the output approximated 500,000 gallons, 60 per cent of which was prepared at Killisnoo, Alaska. The yield of oil ranges from 1 to 4 gallons to the barrel of fish. The value on the Pacific coast is about 20 cents per gallon, and the dried scrap sells for about $25 per ton.

In the preparation of sardines in Europe the heads, viscera, and other waste parts are generally utilized in oil production. They are cooked and pressed, the oil separated, and the refuse used for fertilizer. This oil is employed in leather dressing, cordage manufacture, the preparation of paints for exterior surfaces, and, in some country districts, for illumination. Unfortunately, we have no data bearing on the total extent of the output.

The herring-oil industry in Japan is probably much older than its counterpart, the menhaden industry in America, but it was in a crude state up to about twenty years ago. The species of fish utilized—known as "iwashi"—is found in large schools along the Japanese coast, especially on the northern side of the main island, and very large catches are made in the fall and winter, when the fish are fat.

According to a recent report by Consul Van Buren, of Kanawaga, the principal fisheries are on the island of Yezo and the peninsula of Ava, near Yokohama. The method of extraction is similar to that employed in the United States. The fish are cooked and pressed and the residuum used for fertilizer. The process of refining is likewise similar to that employed in America, the oil being pressed "in small filtering bags of paper, outside of which are similar ones of strong cloth. A number of these are placed in a press, which forces out the oil through the pores of this double envelope."

Japanese herring oil contains an unusually large amount of foots, amounting to about 25 per cent, ac-



MODERN TYPE OF HYDRAULIC OIL-PRESS USED IN THE MENHADEN FACTORIES.

cording to some refiners. On account of this, the weather test of the crude oil is high, from 65 deg. to 70 deg. F. Before the introduction of kerosene in Japan, refined herring oil was employed largely for illumination, but that is greatly reduced. It is now used locally in the manufacture of soap, in leather dressing, in cordage manufacture, as a body for paints, and for other technical purposes.

Since 1881 large quantities have been exported to Europe, and also at intervals to the United States. At first it found little acceptance on account of its unpleasant odor, due to the crude method of extraction. Another objection was the form of the packages, consisting of second-hand 5-gallon kerosene cans, which proved a nuisance to users of large quantities. The Hamburg market price is about 40 marks per 100 kilogrammes for the light oil and 37½ for the brown. The foots, after the process of refining, sell at about 43 marks per 100 kilogrammes.

It is only when domestic fish oils are high that Japanese herring oil can be profitably imported into this country, and on that account the imports fluctuate largely from year to year. The United States markets will receive it at 3 to 5 cents less per gallon than menhaden oil, but it cannot be exported to this country with profit when the menhaden market is less than 26 cents per gallon, since the freights, insurance, import duties, brokerage, etc., would leave very little for the exporter. In 1885 the imports into this country amounted to 101,265 gallons, valued at $24,832; in 1886, 5,010 gallons, valued at $786; then they were insignificant until 1893, when 191,852 gallons, worth $30,746, were received. In 1894 the imports were 156,456 gallons, worth $24,656. Some very choice specimens of refined oil have been received from Japan for exhibition purposes, thus demonstrating what the factories there are capable of producing, but some of the product sent here for consumption could be improved upon.

WATER-SOFTENING.*

AN INQUIRY INTO THE WORKING OF VARIOUS WATER-SOFTENERS.

By C. E. STROMEYER and W. B. BARON, of Manchester.

IT has frequently been stated that scale seriously reduces the heat efficiency of boilers, and experiments have been made which seem to prove this assertion, but it will be found that they have been carried out on wrong lines, and they only prove that scale very seriously interferes with the transmission of heat, if the heat source, usually a flame, is of equal temperature over the whole surface. In a boiler the temperatures vary from 3,000 deg. to 4,000 deg. F. at the furnace, down to 500 deg. to 1,000 deg. F. where the gases leave the boiler. Let us take a simple case, assuming for convenience of calculation that the heat transmission from flame to boiler-plate is proportional to the difference of temperatures. Let the ratio of air fuel be as 20 to 1; let the air temperature be 80 deg. F., then the flame temperature will be 3,000 deg. F. If the steam temperature is 380 deg. F., the maximum temperature on the furnace-plate will, in the above example, be only 20 deg. F. higher than that of the steam, viz., 400 deg. F. Now let us assume that the heating surface is covered with scale ⅛ inch thick; then, if the same quantity of heat were transmitted through the coated furnace-plates as through the clean ones, the temperature difference between one side of the scale and the fire side of the furnace would be 350 deg. F., and the temperature of the plate would be 730 deg. F. It is, however, clear that as the boiler-plate is hotter than in the first example, less heat will be transmitted to it, and the temperature gradient in the scale will be less steep. Naturally also the flame will not get cooled so rapidly, and its temperature, as it reaches the next portion of heating surface, will be higher than before. The temperature distributions will therefore be roughly as follow:

TABLE I.—TEMPERATURE DISTRIBUTION IN A BOILER.

Square feet of heating surface per lb. of fuel per hour	0	¼	½	1	2	4	8
Boiler with Plates Free from Scale.							
Flame and flue temperature dg. F.	3,000	2,421	1,961	1,335	728	426	381
Maximum plate temperature dg. F.	400	336	392	387	383	381	380
Total heat transmitted Per cent.	0	19.8	35.6	57.0	77.8	89.2	89.7
Boiler with Scale ⅛ in. Thick.							
Flame and flue temperature dg. F.	3,000	2,484	2,070	1,471	895	459	384
Maximum plate temperature dg. F.	691	630	561	510	434	389	382
Total heat transmitted Per cent.	0	17.5	31.8	52.4	74.2	87.0	89.5

Boilers are generally designed to have 1½ to 2 square feet of heating surface per pound of fuel burnt per hour under ordinary working conditions. Four square feet in Table I. represents a lightly-worked boiler, and ¼ square foot represents the heating surface usually swept by the flame.

It will be seen from the table that even for this small value of heating surface to fuel the addition of scale ⅛ inch in thickness only reduces the transmitted heat by 11.6 per cent, whereas when the gases reach the end of a lightly-worked boiler, where this value is 4, we find that the total reduction has fallen to only 2.5 per cent. We may therefore safely say that even a thick coating of scale does not materially reduce the efficiency of a boiler. On the other hand, Table I. shows very clearly that even ⅛ inch of wet scale raises the temperature of the furnace-plate in this case by nearly 300 deg. F.

In this particular instance there is therefore danger that the furnace has been sufficiently weakened by heat to be nearly collapsing. Scale is thus a serious danger, and, as is well known, has frequently caused accidents. It will be noticed that in clean boilers the temperature of the furnace-plate is nearly the same as that of the water, whereas in the scaly boiler the excess temperature is about one-tenth of that of the flame. If, therefore, in the first case we open the furnace door and admit cold air, the excess temperature of the furnace-plate can at most be reduced 20 deg. F., causing a contraction of only 1-90 inch in 8 feet, whereas cold air admitted to the furnace of the scaly boiler will effect a rapid reduction of about 311 deg. F., accompanied by a contraction of 1-6 inch in 8 feet, which is a very serious matter. In fact, in a rigid structure these two strains would be accompanied by stresses of 1.5 and 22 tons respectively. Boilers are elastic, but a large fraction of these stresses certainly make their appearance every time that a furnace door is opened, say, once every half-hour, or 6,000 times a year. No wonder, therefore, that in high-pressure boilers, which are necessarily more rigid than low-pressure ones, this constant straining leads to grooving at the furnace flanges. With scale ¼ inch thick the stresses would be nearly doubled.

We thus see that scale does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced. It also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is therefore desirable to remove all scale-forming impurities from the feed water. These impurities are suspended matter, carbonate of lime, sulphate of lime, magnesium salts, and grease. One has also to be on one's guard against introducing large quantities of soluble salts, as these concentrate when the water evaporates, until thick scales of crystals are formed.

Let us examine the behavior of these various impurities.

Suspended matter is often organic, and appears to have a beneficial effect on such mineral precipitates as may be formed by combining with them and forming loose sediment, which is easily dealt with in water-softeners, or it settles down as mud in boilers. Some suspended matter, such as fine sand, and more particularly paper pulp, settles on the furnaces and leads to collapses.

Carbonate of Lime is the Chief Cause of Temporary Hardness.—Its chemical formula is $CaCO_3$. It is practically insoluble in water, but it is easily converted into bicarbonate of lime, having the formula $CaH_2(CO_3)_2$, which is fairly soluble in cold water, and is a constituent of most natural waters. Its second equivalent of carbonic acid is easily removed on boiling, when, of course, the carbonate of lime is precipitated, forming a scale. The slower this reaction is carried out, the slower the heating, the more chance is there for this carbonate of lime to form crystals—called calcite in mineralogy—which constitute a fairly hard scale, as found in economizers, where the conditions are very favorable to its production. This explains why, in the south of England, where the waters contain much temporary hardness, economizers are very little used, for they would get choked unless the waters be first softened. Waters poor in carbonate of lime, but rich in sulphates, do not choke the economizer pipes. If the heating is effected rapidly, as, for instance, when natural waters are pumped direct into the steam space of a boiler, the precipitation of carbonate of lime is so rapid, that only a mud is formed. Another means of converting bicarbonate of lime into carbonate of lime is to add solutions of caustic lime, burnt lime, or caustic soda in water. For solubilities see Appendix I. The chemical reaction is as follows:

$$\left.\begin{matrix}\text{Bicarbonate}\\ \text{of calcium}\end{matrix}\right\} + \left\{\begin{matrix}\text{Caustic}\\ \text{lime}\end{matrix}\right\} = \left\{\begin{matrix}\text{Carbonate}\\ \text{of lime}\end{matrix}\right\} + \text{Water}$$
$$\underset{\text{Soluble}}{CaH_2(CO_3)_2} + \underset{\text{Soluble}}{CaO} = \underset{\text{Insoluble}}{2CaCO_3} + \underset{\text{Water}}{H_2O}$$

The second equivalent of the carbonic acid in the bicarbonates of lime and of magnesia is generally called half-bound. Any excess is called free carbonic acid. Of course, sufficient lime is required to neutralize both.

In the Table of Chemical Analysis the bicarbonate of lime is split into carbonate of lime and carbonic acid, because the latter disappears on boiling. One grain of carbonic acid combines with 2.27 grains of carbonate of lime, forming 3.27 grains of bicarbonate of lime. Temporary hardness cannot be entirely removed by lime treatment, because carbonate of lime is not absolutely insoluble.

Sulphate of Lime.—The chemical formula is $CaSO_4$. It is fairly soluble in waters up to the boiling point at atmospheric pressure, but it is less soluble at temperatures corresponding to high pressures of steam (Appendix I.). Because this sulphate of lime cannot be removed by ordinary boiling, it is called permanent hardness. One grain of sulphate of lime equals 0.7350 permanent hardness. The result is that if waters containing sulphate of lime are pumped into a boiler, the constant evaporation effects a slow concentration until saturation point is reached, when the sulphate of lime is precipitated so slowly that it crystallizes and adheres to all parts of the boiler, but more particularly to the hottest parts; then, whenever the pressure drops—and with it the temperature—part of the precipitate is redissolved, the spaces between the crystals are filled with concentrated solutions of sulphate of lime, which crystallizes out again on heating, whereby the originally small and loose crystals are enlarged and are firmly cemented together, forming a very hard scale, which can only be removed by chipping or by heating; it is practically gypsum or selenite. If any carbonate of lime is mixed up with the scale, this, too, gets thoroughly cemented with it.

At the temperatures corresponding to high pressures, water can dissolve only about 20 grains of sulphate of lime per gallon. On cooling down a boiler and letting it stand for some time, the water will dissolve parts of the crystals until there are about 170 grains to the gallon. This dissolving action loosens the scale, which can be easily removed as long as it is wet. If the scale be allowed to dry, all the 170 grains of sulphate crystallize, and thereby cement together the loose parts of the scale, making it hard and difficult to remove.

The principle of pumping feed water into a trough in the steam space of a boiler has several times been patented, but as boiler water can hold up to 20 grains of sulphate of lime in solution, this method is of no benefit with waters having less permanent hardness than 15 deg.

The sulphate of lime can always be entirely removed by conversion into carbonate of lime. The reaction is as follows:

$$\left.\begin{matrix}\text{Sulphate}\\ \text{of lime}\end{matrix}\right\} + \left\{\begin{matrix}\text{Carbonate}\\ \text{of soda}\end{matrix}\right\} = \left\{\begin{matrix}\text{Carbonate}\\ \text{of lime}\end{matrix}\right\} + \left\{\begin{matrix}\text{Sulphate}\\ \text{of soda}\end{matrix}\right.$$
$$\underset{\text{Soluble}}{CaSO_4} + \underset{\text{Soluble}}{Na_2CO_3} = \underset{\text{Insoluble}}{CaCO_3} + \underset{\text{Soluble}}{Na_2SO_4}$$

If there is any free or half-bound carbonic acid in the water—and this is generally the case—caustic soda, if available as a waste product, may be used. The caustic soda combines with the carbonic acid to form carbonate of soda, and the reaction is then as sketched above; and the lime which has lost its one equivalent of half-bound carbonic acid is also precipitated. Caustic soda without carbonic acid will not precipitate the sulphate of lime. It is therefore wrong to introduce caustic soda into boilers which are fed with water having only permanent hardness. In fact, caustic soda should not be pumped into a boiler except together with the cold feed; for as long as the water is cold, the carbonic acid can be fixed, and additions of caustic soda would come too late if made in the boiler.

The above-sketched chemical reaction can easily be carried out in water-softeners, but the separation of the precipitate is as slow as in the last case; and, unless heat is applied, the newly-formed carbonate of lime has to settle for a long time.

Magnesium Salts.—These are found in natural waters as nitrates, chlorides, sulphates, and cause permanent hardness, or as bicarbonate, which causes temporary hardness; they are very soluble, except the last-named. They all react on soap, and heat will not precipitate them, except the bicarbonate, by driving off its carbonic acid. At the high temperatures to be found in boilers a reaction resulting in precipitation of magnesia takes place between the carbonate of lime and the soluble magnesium salts. The bicarbonate of magnesia can be partly removed by converting it into carbonate of magnesia by the addition of caustic lime.

The reaction in water-softeners is as follows:

$$\left.\begin{matrix}\text{Bicarbonate}\\ \text{of}\\ \text{magnesia}\end{matrix}\right\} + \left\{\begin{matrix}\text{Caustic}\\ \text{lime}\end{matrix}\right\} = \left\{\begin{matrix}\text{Carbon-}\\ \text{ate of}\\ \text{magnesia}\end{matrix}\right\} + \left\{\begin{matrix}\text{Carbon-}\\ \text{ate of}\\ \text{lime}\end{matrix}\right\} + \text{Water}$$
$$\underset{\text{Soluble}}{MgH_2(CO_3)_2} + \underset{\text{Soluble}}{CaO} = \underset{\text{Slightly soluble}}{MgCO_3} + \underset{\text{Insoluble}}{CaCO_3} + \underset{\text{Water}}{H_2O}$$

The last traces of magnesium carbonate are removed by adding an excess of lime, the reaction being as follows:

$$\left.\begin{matrix}\text{Carbon-}\\ \text{ate of}\\ \text{magnesia}\end{matrix}\right\} + \left\{\begin{matrix}\text{Caustic}\\ \text{lime}\end{matrix}\right\} + \text{Water} = \left\{\begin{matrix}\text{Hydrate of}\\ \text{magnesia}\end{matrix}\right\} + \left\{\begin{matrix}\text{Carbon-}\\ \text{ate of}\\ \text{lime}\end{matrix}\right.$$
$$\underset{\text{Slightly soluble}}{MgCO_3} + \underset{\text{Soluble}}{CaO} + \underset{\text{Water}}{H_2O} = \underset{\text{Insoluble}}{Mg(OH)_2} + \underset{\text{Insoluble}}{CaCO_3}$$

The other magnesium salts react in a similar way, being easily converted into carbonate and hydrate by the addition of burnt lime and soda ash.

The carbonate of magnesia ($MgCO_3$) is very slightly soluble in water, whereas the hydrate of magnesia [$Mg(HO)_2$], is practically insoluble, but being a gelatinous mass, it causes serious difficulties in water-softeners, more especially by clogging the filters.

Grease.—This is, of course, only found in the waters discharged from jet or surface condensers, or from feed-heaters in which steam is condensed. Vegetable and animal fats cause corrosion in boilers; but as they are unsuitable for cylinder lubrication, they are now rarely used, and heavy mineral oils have been found to be more suitable. Modern marine practice tends toward the running of engines without any cylinder oil; but factory engines still consume large quantities, and thereby contaminate their feed-water if drawn from the condenser. Part of this grease floats on the water and could be removed by filtration; probably it does little harm if it gets into the boiler, but a small trace is emulsified in the water and is very difficult to deal with. It cannot be separated from water by boiling at atmospheric pressure; but it is completely removed by the conditions which exist in a boiler, and as it adheres to the heating surfaces, it causes overheating, which may result in a collapse, and certainly increases the wear and tear.

The peculiarity of grease deposits in boilers is that their effect is out of all proportion to their thicknesses. We have seen that scale of ⅛ inch thickness will raise the temperature of furnace-plates about 300 deg. F. As grease offers ten times more resistance to heat, one would expect that 1-80 inch would have the same

* Paper read before the Institution of Mechanical Engineers.

effect as this thickness of scale, but experience shows that the merest trace of grease, certainly less than 1-1000 inch, or one-tenth of the above, can cause far more serious injury than scale. Various explanations have been attempted. According to one of these, thin films of grease form tough bubbles on the heating surface and prevent the water from keeping it cool. Another view is that grease, either alone or joined to mineral matter, forms an impalpable powder like oxalate of lime and other precipitates, and, like these, retards ebullition. In support of these views we find a fairly well-founded belief that grease in boilers is more injurious if these boilers are clean than if they are coated with mineral scale, and against this view we have the undoubted experience that land boilers with scale at once give trouble if condensed water is used instead of natural water. Increase of pressure above 110 pounds seems to accentuate this evil; perhaps this may be due to decomposition of magnesium carbonate when this temperature is reached. In any case it is highly desirable to remove every trace of grease from the feed water. As already stated, this cannot be done by filters; and grease separators, which appear to be rather more efficient, do not remove the last trace of grease.

As yet the only effective method for doing this is to add mineral matter in solution to the condensed water and then to cause precipitation by chemical means. The grease then adheres to the precipitate and can easily be removed by settlement or filtration. Water from jet condensers contains the necessary mineral matter, but this has to be added if the waters are drawn from surface condensers.

The preceding remarks may be here briefly summarized.

Carbonate of lime forms hard scale in economizers and a soft mud in boilers, unless sulphate of lime is present, when it also is cemented into a scale. Carbonate of lime can be removed by boiling or by adding enough caustic lime or caustic soda to combine with the free and half-bound carbonic acid which holds it in solution.

Sulphate of lime forms no scale in economizer pipes; but it forms a very hard scale in boilers, and also cements the carbonate of lime deposits. Its deposition in boilers is due to slow concentration of the water; and it is therefore desirable to remove the salt entirely. This can always be done by adding carbonate of soda, which converts it into carbonate of lime.

Carbonate of magnesia generally behaves like carbonate of lime, except that it is slightly more soluble.

The other salts of magnesia are very soluble. They seem to cause corrosion, and should be removed. This can be done by treating them like the sulphate of lime, by adding carbonate of soda.

Grease should, if possible, be kept out of the boiler. Neither separators nor filters will remove it entirely from feed waters; but this can be done by mixing them with impure waters and treating them in water-softeners.

The cost of raising the temperature of 1,000 gallons of water from 60 deg. to 212 deg. F. is about 1s. when the price of coal is 12s. per ton, no matter what the hardness of the water may be. With water of 10 deg. temporary hardness 1.14 pounds of caustic soda of 77 per cent strength, or 0.8 pound of burnt lime, will suffice for 1,000 gallons of water. The same quantities will also neutralize all the free carbonic acid represented by 6 grains per gallon. As the prices of caustic soda and lime stand in the ratio of 12s. 6d. to 1s. per hundredweight, the relative costs of the two treatments would be 1.53d. and 0.09d. per 1,000 gallons, and, naturally, one would use caustic soda only if it is a waste product and if there is permanent hardness also present. Large proportions of soda, either carbonate or caustic, affect brass fittings.

It requires 1.5 pounds soda ash of 58 per cent strength to remove 10 deg. permanent hardness out of 1,000 gallons; as the price of this soda is about 5s. 6d. per hundredweight, the cost would be about 0.88d. per 1,000 gallons. The strength of washing soda is about 20 to 22 per cent.

In some water-softeners, such as the Archbutt-Deeley and the Lassen and Hjort, caustic lime and carbonate of soda are mixed, producing a milky fluid, which consists of caustic soda, free lime or free soda ash, and insoluble carbonate of lime, the latter substance being, of course, a useless constituent. The cost of the caustic soda so produced would be about 6s. per hundredweight.

The interest and depreciation of the softening plant, the attendant's time—generally only half an hour a day—have to be added to the above expenses. If the waters are treated in the boilers—when burnt lime may, of course, not be used—the cost of removal of the scale and the wear and tear of the boiler, due to overheating, have to be added. The following table (II.) shows the relative cost of working installations of from one to seven boilers. Each boiler is supposed to be 8 feet in diameter, and to have cost £800, including setting, etc. The interest on the first outlay and on the sums annually set aside for depreciation and renewal is taken at 3 per cent. The best-worked boiler using pure or softened water is supposed to last fifty years, and the last boilers on the table are supposed to last only fifteen years, and have to be opened out and scaled every three months. The other boilers, having each a spare one in the set, are supposed to last the number of years shown in the table. In each case except the first the water is supposed to be very sedimentary.

It will be seen that according to this estimate, boilers using pure water should not cost more than about £35 per annum, including chemicals in water-softener; whereas the other boilers, using sedimentary water and boiler compositions, may cost twice and three times as much. The minimum saving, say £30, capitalized at 5 per cent, represents £600, whereas the cost of a water-softener per boiler would amount to about £100 to £200.

TABLE II.—HYPOTHETICAL.

Nature of Feed.	Pure.	Very Sedimentary Water.						
Boilers at work	1	1	2	3	4	5	6	6
Spare boilers	0	1	1	1	1	1	1	0
Assumed life of boilers	50	40	40	40	40	30	20	15
	£	£	£	£	£	£	£	£
Interest on first cost	24	48	72	96	120	144	168	144
Depreciation	7	21	32	42	52	100	209	258
Scaling and cleaning at 30s.	2	20	30	59	78	78	78	36
Chemicals	2	10	20	30	40	50	60	60
Total	35	99	153	227	290	372	515	498
Totals per working boiler	35	99	71.5	75 7	72.5	74.4	85 8	83*

* The actual cost would be much greater, as the works would be closed down for four weeks per annum.

We have now to turn our attention to some of the practical difficulties which water-softeners have to overcome, the most important of these being the proper adjustment of the supply of chemicals and the removal of the precipitates from the treated waters. If, by suitable chemicals, we precipitate carbonate of lime out of water, it is at first in a colloidal condition, its first appearance being that of a bluish-white thin starch, which can freely pass through the best chemical filters, and could never be arrested by wood-wool, cloth, or sponges. If this fluid is allowed to stand for a considerable time, or if it is heated a little, the precipitate settles down, changing to a yellowish color, and no amount of shaking will again convert it back to its original condition; but even now this precipitate is so fine that it settles down very slowly. According to Prof. Wanklyn's experiments this precipitate will settle down in 25 minutes through ¾ inch of water, which will then be quite clear, whereas it takes 8 hours to clear 20 inches of water charged with this precipitate. The rate of settlement is about 1.8 inch to 2.5 inch per hour. No experiments seem to have been made on hot water.

It is thus understood why very large tanks are necessary when working with cold water, and why even filters will not remove all the precipitated carbonate of lime.

When the softening operation is carried out hot, these settling tanks, as can be seen by comparing various softeners, may be much reduced in size, and filters now become far more effective than before.

In most of the cold-water softeners the treated water moves upward against the descending sediment, which, being coarse, assists the newly-formed precipitate in settling down. In other softeners—notably in that of Desrumaux—the treated water is made to travel in comparatively thin sheets. Thus, by dividing the tower into narrow layers, the precipitate has not to fall very far. This principle may be carried too far, for the thinner and longer the sheet of water, the greater the velocity and the stronger the eddies.

In spite of the use of very large settling tanks, supplemented by filters, there are very few cold-water softeners which can be relied upon to remove all the solid matter which the added chemicals have precipitated, and serious complaints are not infrequently heard that after the installation of a water-softener, the injectors or feed pipes get choked with scale. Evidently all the chemical precipitates do not settle down thoroughly until the comparatively hot pipes are reached.

To overcome this difficulty the Archbutt-Deeley process is arranged so that the carbonic-acid gas from a stove comes in contact with the treated water and dissolves the trace of precipitate which would have appeared in the pipes. Steam users, however, have a prejudice against deliberately introducing carbonic acid into their boilers, and some at least add very large settling tanks, and do not use the stove. Unquestionably the most effective way of removing the residual precipitate would be to heat the treated water; but, as already shown, that is a very expensive remedy.

In practice magnesia precipitates are still more difficult to deal with than the lime precipitates, because of their gelatinous nature, which, although it assists in separating out the carbonate of lime, also retards the settling process, and seriously interferes with the working of filters. Here again heat is a remedy, but only a partial one, and is very costly. Nevertheless, several of the softeners dealt with in this paper seem to have removed large quantities of magnesia without choking their filters.

In the Archbutt-Deeley softener, which, due to a sufficiency of lime, has effectively removed nearly all magnesia salts, each new tankful of treated water is mixed with the sediment of the previously treated waters, the settlement being expedited by the adhesion of the old and coarse particles to the new flocculent and gelatinous precipitates. The same principle is adopted in those softeners in which the treated water is led to the bottoms of the settling tanks, and has to pass through previously precipitated mud. Use is also made of the precipitated mud for the removal of grease in the apparatus of Babcock & Wilcox, Boby, Maxim, and Wollaston, in which exhaust steam is introduced. The explanation of the cause of this removal is doubtless to be found in the coagulation of the first-formed colloidal precipitate, which, on separating, effectively removes both the oil in suspension and in the emulsified state. Wollaston finds that the greasy scum rises upward, and at the top of his reaction tower a scum-tap is fitted, and the exit from this tower to the settling tank is placed some distance below, thereby preventing this scum from contaminating the softened water.

Out of seventeen continuous water softeners dealt with in this paper fourteen are fitted with filters. Two of these, Bell's and Reisert's, are sand filters. Porter-Clark and Atkins have cloth filters, and the others have wood-wool or sponge filters. Wood-wool is cheap and can be renewed, say, twice a year, while sponges have to be cleaned. These removal or cleaning operations are rather tedious, but cannot be entirely obviated. Those filters through which the water passes downward, and on to which the sediment falls, have, of course, to be cleaned much more frequently than those through which the water passes upward.

Cloth filters have to be cleaned by hand. They generally consist of a number of wooden or iron frames, each frame being separated from its neighbor by a piece of cloth. The frames are pressed together by two long bolts. The water enters every alternate frame through a hole in the top side or middle, and is discharged out of holes in the bottoms of the adjoining frames. The cloths are easily removed by slacking back the nuts on the long bolts. The Atkins filters are circular disks, which are brushed clean without removing them.

The second difficulty encountered in practice is that of properly apportioning the chemicals.

It appears that in all water-softeners the chemicals are dissolved in water, or, at least, mixed with it, and the introduction of small measured quantities of powdered slaked lime and of powdered soda does not appear to have been tried, and numerous complicated and ingenious contrivances have been devised for overcoming the difficulties which are encountered when using fluids.

Thus, caustic lime, as will be seen by Appendix I., dissolves only very sparingly in water, the quantity decreasing with rising temperature from 91 grains at 60 deg. F. down to 40 grains at 212 deg. F. At about 70 deg. F. the solubility decreases at the rate of about ½ per cent for every 1 deg. F. rise of temperature. It requires 1¼ grains of caustic lime, or about 1-70 gallon of lime water, to precipitate the carbonate of lime, which is dissolved in water containing 1 grain of a free carbonic acid, and as this free carbonic acid is rarely less than 7 grains per gallon, it is generally necessary to add quite 10 per cent of lime water. This lime water is prepared by throwing slaked lime into a deep tank and letting unsoftened water flow slowly through the milk of lime in the bottom. If the flow is slow enough, and the tower high enough, the overflow is clear saturated lime water. The relative quantity of lime water to untreated water is regulated by letting both streams emerge from a single tank having adjustable nozzles or weirs. Except that the lime tank must be high, and that it ought to be provided with stirrers near the bottom, this arrangement is a fairly convenient one. It is used by Atkins, Desrumaux, Reisert, and Stanhope.

APPENDIX I.—SOLUBILITIES.

Temperature.	Corresponding Steam Pressure.	Chemicals and Experimenters.			
		Calcium Oxide. (Caustic Lime.)	Calcium Sulphate.		
		Lamy, 1878.	Marignac 1874.	Poggiale. 1879.	Tilden and Shenstone.
deg. Fahr.		Grains per gallon.			
32	....	96 7	133.0	143.5	
40	....	91 0			
59	....	91 0			
64.4	...	....	143.0		
68	....	...		168.7	
75.2	.	....	146.5		
86	...	81.4			
95	....	....	....	177.8	
101.5	....	. .	150.3		
111	....	70.1			
127.4			147.0		
140	....	70 8			
158	....	....	...	170.8	
161.6	....	....	140.8		
210.2	..	...	122.6		
212	0	40.2	....	151.	
281	37	....	...	....	54 6
323.6	79	...	....	....	39 2
356	131	....	....	....	18.9
464	484	....	....	....	12.6
482	575	....	. .	....	12 6

The apparatus can, of course, be made much smaller if milk of lime containing, say, 10 per cent caustic lime, is used instead of clear lime water; but then it is imperative that this milk of lime should be perpetually stirred, as in the Bell, Boulton, Harris-Anderson and Porter-Clark softeners; nor is it permissible to add water during the working day, as appears to be the case with the Harris-Anderson softener. The mixture is thereby made weaker and weaker. In the Lassen and Hjort softener the quantity of milk of lime and soda solution, injected with each tilt of the water trough, is regulated by the duration of the opening of a small valve; but as the head of the reagent diminishes during the working day, so does the quantity of injected fluid, and it has been found necessary to keep the chemical tank half full. These two examples will suffice to show that, in spite of some advantages, the use of milk of lime is perhaps attended with more difficulties than is the use of lime water.

(To be continued.)

SOME NOVEL PHENOMENA IN CONNECTION WITH N RAYS.

In an article published in the April issue of the Journal de Physique, Prof. Blondlot records some interesting novel phenomena observed by himself in the course of his researches on N rays. The photographic record of the effect exerted by the rays on a small electric spark is discussed among other facts. N rays, as is well known, do not themselves exert any photographic action. As shown by Blondlot as far back

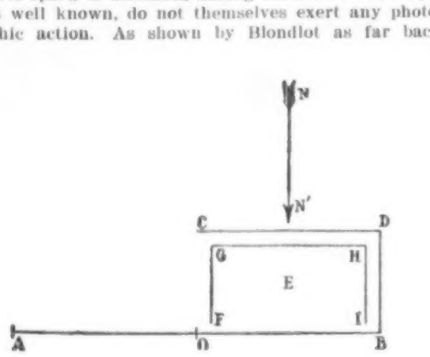


FIG. 1.

as in May of last year, the action of N rays may, however, be evidenced indirectly by causing a small illuminant to act on a photographic plate for a given time, while the illuminant is being struck by N rays, and repeating the same experiments during the same period and under the same conditions, after the N rays have been eliminated, whereupon the impression is considerably weaker than when the N rays are allowed to act. Now this method has lately been improved considerably. The apparatus used is shown in Fig. 1. *AB* is a photographic plate 13 centimeters (5.11 inches) wide; *E* is the electric spark inclosed in a pasteboard box, *FGHI*, which is open on the side facing the plate, and *CD* is a lead screen lined with moistened paper, rigidly attached to the plate holder containing the plates. The N rays arriving from any source will form a bundle having the direction of the arrow, *NN'*.

With this arrangement, the N rays are arrested by the screen, *CD*, the spark being protected against the action of the rays while acting on the half, *OFB*, of the plate.

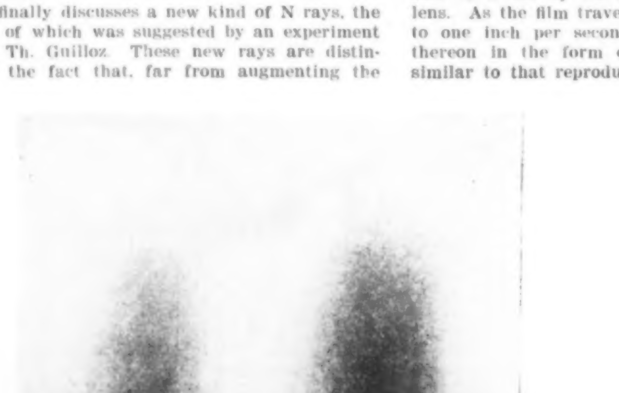
Now if the plate holder be shifted half its width to the right (Fig. 2), the half, *AO*, of the plate will coincide with the place formerly occupied by *OB*, when the screen, *CD*, will no longer be in the path of the N rays. The half, *AO*, of the plate will accordingly be exposed to the action of the electric spark influenced by the N rays.

The experiments were made by leaving the plate for five seconds in the first and afterward in the second position. After having been placed again in the initial position, this alternative shifting of the plate was continued a certain number of times. After numerous five-second exposures totaling about 100 seconds had been made, either part of the plate had been exposed to the spark the same number of times.

As shown in a most striking way, in the pictures published by Blondlot, the photographic action is very much stronger in the case of the spark being influenced by the N rays, this result having been found uniform in some forty experiments with N rays of different origin.

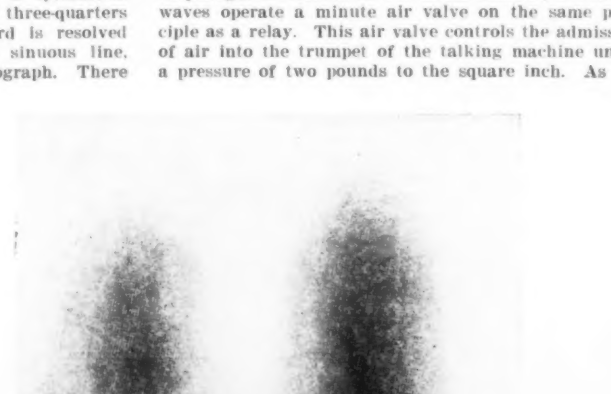
Blondlot further points out that the N rays given off from a Crookes tube are polarized. In the case of the longitudinal direction of the electric spark being at right angles to the axis of the tube, the photographic image of the spark is quite faint, whereas in the case of both being parallel, the maximum of intensity is noted.

Blondlot finally discusses a new kind of N rays, the observation of which was suggested by an experiment due to Dr. Th. Guilloz. These new rays are distinguished by the fact that, far from augmenting the



Photograph of a spark without N rays acting upon it. Photograph of a spark with N rays produced by acting upon it.

FIG. 3.



Photograph of a spark without N rays acting upon it. Photograph of a spark with N rays produced by a Nernst lamp.

FIG. 4.

brilliancy of a faint illuminant, they will exert a weakening action. As Blondlot, in connection with previous experiments, had decomposed the N ray bundle given off by a Nernst lamp into its spectral components by means of an aluminium prism, he readily succeeded in finding out among these separated radiations those showing this opposite behavior; the rays, termed N_1 rays by Blondlot, all lie in the least deviated region of the spectrum. It is interesting to note that the curve representing the refraction index in terms of the wave length, seems to be the same for both kinds of rays.

An observation recorded by Blondlot is likely to throw some light on the multiple contradictions shown by the experiments of various physicists. If a faintly illuminated surface, for instance, a phosphorescent screen, be inspected at right angles, a brightening effect of the N rays is observed; looking, on the other

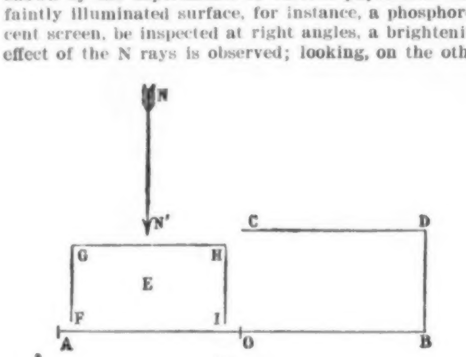


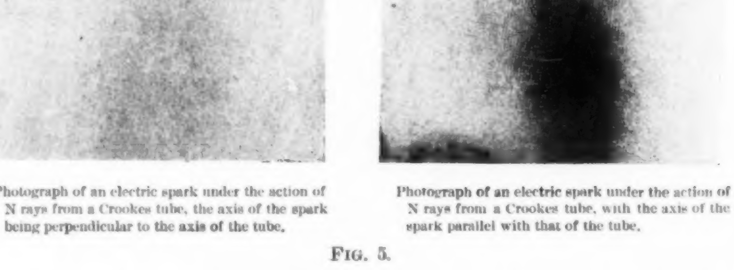
FIG. 2.

hand, at the surface at a rather oblique angle—in fact, nearly tangentially—the surface is found to become less luminous under the action of the N rays. These rays therefore will increase the amount of light given off at right angles, and diminish the amount given off in a rather oblique direction. Of course, there is an intermediate position for which no effect is observed. The action of the N_1 rays above mentioned shows an opposite behavior.

SOME NEW SCIENTIFIC EXHIBITS AT THE SOIREE OF THE BRITISH ROYAL SOCIETY.

By the English Correspondent of the SCIENTIFIC AMERICAN.

The annual soiree of the Royal Society of Great Britain, recently celebrated in London, was productive



Photograph of an electric spark under the action of N rays from a Crookes tube, the axis of the spark being perpendicular to the axis of the tube.

Photograph of an electric spark under the action of N rays from a Crookes tube, with the axis of the spark parallel with that of the tube.

FIG. 5.

of many highly interesting scientific devices. The exhibits were of a wide and comprehensive variety, concerning all ramifications of scientific interest and study.

One of the most interesting devices demonstrated was the Mallock vibrograph constructed by the Cambridge Scientific Instrument Company. This apparatus is for the photographic recording of the vibrations of the flooring of a building, or even the building itself. There is a traveling photographic film, upon which is projected and recorded the magnified image of a quartz fiber, illumined by artificial light and reduced to the size of a dot by its passage through a cylindrical lens. As the film travels at the rate of three-quarters to one inch per second this dot record is resolved thereon in the form of a continuous sinuous line, similar to that reproduced upon a barograph. There is a heavy metal plate suspended by a spring which has a vertical motion. Vibration in any other direction is prevented by five steel rods which have pointed ends reposing in steel cups, in such a way that there is no apparent friction. All these rods are maintained in a state of compression by means of suitable fixture of the spring. A microscopic objective is fitted to this plate, through which the beam of light is transmitted to the photographic film behind. Therefore any vertical motion of this objective causes a consequent magnified displacement of the spot of light, and the continuous record is thus obtained. The proportion of the displacement of the spot of light in this particular instrument is 75 to 1.

The film is moved over a drum, the necessary driving power being supplied by a falling weight. The motion of this drum is resisted by a viscous fluid, such as treacle, and any degree of revolving speed of the drum may be obtained by the adjustment of the thickness of the liquid between the plate and the moving conical surfaces. On the recording film at intervals of half seconds are registered laterally time marks produced by an electrically operated time marker. It was with an instrument of this type that the extent of the vibrations caused to buildings in the vicinity of the deep-level Central London Railroad were obtained.

A new type of high-power microscope was exhibited by Mr. J. W. Gordon. It is a well-known fact that when high magnification is attempted by a series of lenses arranged in the conventional manner, the emergent beam of light which enters the eye of the observer is so small that vision is deficient, owing to the fact that the pupil of the eye is not entirely filled with light. It is consequently apparent that in order to obtain satisfactory results in excessive magnification the emergent ray should be expanded in such a way as to fill the pupil of the eye. This result is achieved in this microscope of Mr. J. W. Gordon. It comprises an ordinary microscope with an eccentrically rotating glass screen with a finely-grained surface placed in the view field. This is viewed through a second microscope which has an object glass of half an inch, by means of which a further magnification of 100 diameters is rendered possible. The transmitted emergent beam is expanded by the ground glass screen so that it fills the second microscope and there are no imperfections whatever in the magnifications. The inventor demonstrated this by magnifying a diatom to 10,000 diameters, and its structure was perfectly clear and defined right to the edges. A comprehensive idea of the extent of this excessive magnification may be gathered from the fact that if the eye of an ordinary house fly were magnified on the same scale it would cover an area of 312 feet. The idea of the ground grained screen being made to revolve is to prevent the grain thereon becoming visible and thereby interfering with the magnifying of the subject under observation, while as it is not in contact with either of the microscopes there is a complete absence of vibration.

The Hon. C. A. Parsons, the inventor of the steam turbine, also had a highly interesting exhibit, the auxetophone. This may be described as a kind of pneumatic-acting stylus for the phonograph. Instead of the recording stylus of the instrument causing the diaphragm to vibrate in the usual manner, the sound waves operate a minute air valve on the same principle as a relay. This air valve controls the admission of air into the trumpet of the talking machine under a pressure of two pounds to the square inch. As the stylus passes over the record a small but sufficiently powerful puff of air is admitted by the valve with every vibration. The result is that the sound is reproduced with extraordinary clearness and loudness, while there is a complete absence of that harshness so generally a feature of a gramophone reproduction. The sounds even of the lightest and most indistinct char

acter are reproduced with great volume, rendering the instrument astonishingly flexible.

Another phonograph improvement is that of Mr. T. C. Porter, the scope of which is the reinforcing of the sound emitted. This is effected by the dispensation entirely of the reproducing trumpet. In its place, however, a mixture of coal gas and air under a slight pressure is passed over the diaphragm through two India rubber tubes terminating with jets. These two jets are set at an angle in much the same manner as the gas holes in an acetylene gas burner, with the same resultant effect—the spreading out of the gas issuing therefrom into a sheet. The gas is then ignited and the phonograph set in motion. By this ingenious arrangement the articulation of the instrument is reproduced with extra force and commendable distinctness. It is the ignition of the gas that reinforces the sounds, since, if the burners are not lighted, the articulation is only feebly rendered.

The new sensitive barograph for the record and study of the minor variations in atmospheric pressure and temperature, devised by Dr. W. N. Shaw, F.R.S., and Mr. Dines, was also shown. This apparatus consists of an inverted cylinder which has communication with a sealed air vessel which floats, mouth downward, in a bath of mercury. There is a simple lever device at the top which serves to increase the vertical motion of this cylinder. Feathers are placed in the air vessel and the air is permitted to escape through a glass tube. Although this barograph is not adapted to gradual changes of the atmospheric pressure and temperature, yet it shows those deviations which are not recorded by the ordinary barograph, such as the variations during a thunderstorm and sudden darkness.

Among the electrical exhibits was Dr. Fleming's apparatus for the investigation of stationary electric waves on spiral wires. This apparatus comprises a long horizontal solenoid of insulated wire, to one end of which an electric vibration of high frequency set up the discharge of an induction coil in a circuit with an adequate inductance and capacity, is applied. This electric vibration causes electric waves to travel through the solenoid at the high velocity of 1,500 miles per second. Arriving at the opposite terminal of the solenoid the electric oscillations, being unable to traverse any farther, are rebounded back again, the result being what are termed stationary waves along the coil. The presence herein of these waves is easily ascertained by means of a vacuum tube which when it is brought into close proximity with the coil immediately glows, the intensity increasing or decreasing in accordance with the approach of the tube to the loop or node of a wave. To demonstrate the presence and positions of the loops and nodes respectively the exhibitor placed a series of vacuum tubes along the spiral, and the glows produced therein were of varying intensity. As the inductance and capacity of the oscillating circuit are known, it enables the frequency of vibration to be calculated, and by applying the oscillation of this known frequency to the end of a solenoid, the inductance and capacity of which are also known, the formation of waves of a definite velocity is obtained. Then when the calculated velocity is divided by the wave lengths on the solenoid, the frequency of the waves is ascertained, and this result agrees closely with that obtained with the calculations produced from the constants of the Leyden jar circuit.

Mr. Bertram Blount, F.I.C., showed two electric furnaces for laboratory service. One furnace consisted of platinum foil wound spirally round a porcelain tube, the heat being generated by the resistance thereby produced to the current. In the other device there was a pair of concentric tubes of porcelain with the annular space between filled tightly with a mixture of powdered graphite and siloxicon. The current is passed through this by copper clamps fixed at either end. These furnaces have been proved by the inventor to be particularly adapted to analytical investigations, being superior to the ordinary gas furnace for this work.

Another interesting device, but only partially electrical in its action and operation, was exhibited by Col. R. E. Crompton, C.B. This was Mr. Price's electrical micrometer for the measurement of screws and small mechanical parts.

In connection with radio-activity investigations there were some specimens of the new mineral thorite from Ceylon. This substance, according to Sir William Ramsay's investigations, contains a new radio-active mineral thorianite, which is particularly rich in thoria, containing, as it does, some 76 per cent of the latter and yielding 3.5 cubic centimeters of helium per gramme.

Some interesting photographs illustrating induced radio-activity of bacteria when submitted to the influence of radio-active salts, were on view. The exhibitor, Dr. Alan B. Green, had taken small groups of bacterial growth and had exposed them to the β and γ rays of pure radium bromide for several hours. They were then placed between glass plates, near the sensitized film of a rapid photographic plate. When this was developed there were visible thereon dark patches which corresponded in position to the masses of bacteria. The emanations from the bacteria even after exposure affected the photographic plate through a double layer of lead foil, which offered no resistance to their passage. The curious fact was observed that the spore-producing organisms evinced a stronger action on the sensitized plate than the other portions.

There were samples of methyl, and several other compounds of sulphur, selenium, tellurium, and so forth, obtained by Dr. A. Scott, F.R.S.

Very interesting were Lord Avebury's models of mountain building. These are produced by taking casts from layers of baize, cloth, and sand, compressed tightly at right angles to one another in both directions by means of four beams. By drawing the beams toward one another the sand is forced up and flattened against the glass plate covering it. By means of these casts it is seen that the ridges in the lower strata are more precipitous and narrower than those in the higher layers. Although the ridges follow the edges, they do not do so very closely.

Mr. E. J. Garwood, professor of geology at University College, has devised a portable apparatus for sounding lakes situate in mountains which are difficult of access and where boats are not possibly available. There are two posts, together with a float, and an ordinary air cushion, through a hole in the center of which the plummet descends. Two wheels are attached to one of the posts and the sounding lines run over these. When the wheels are coupled together the float moves and the plummet is stopped, but by uncoupling the wheels the plummet sinks and the depth to which it descends is read off on ordinary counters. With this portable sounding machine Mr. Garwood has carried out with great success several sounding operations, notably in the Alpine region of Lake Ritom, at an altitude of 9,000 feet on the watershed. He has successfully recorded in this manner depths of as much as 170 feet.

One of the most novel and at the same time simple appliances was the cylindrical telescope for the rotation of images, which was exhibited by Dr. G. J. Burch, F.R.S. There are two cylindrical lenses mounted in a telescope. One corresponds to the object glass and can be rotated about the axis of the tube, while the telescope itself is pivoted in such a manner that it also can be turned in the horizontal plane. When in its normal position the objects are inverted by the telescope like a mirror. When the telescope is turned the image traverses through double the horizontal angle. Now if the axis of the object lens is changed at this point, the image moves up and down either vertically or obliquely, and it will remain stationary when the two axes are at right angles. But the main point is that during the movement of the image the polarization plane always remains unaffected. Owing to the simplicity and ingenious character of this instrument it should prove of immense value to the teacher or optician.

N-RAYS. THEIR OSCILLATORY EFFECTS.

M. AUG. CHARPENTIER brings out some remarkable phenomena in connection with the N-rays which are given off when a nerve is excited. He previously showed that upon exciting a nerve in any way its production of N-rays is increased, and again that these rays could be transmitted to a phosphorescent screen by a wire which can be displaced along the nerve, and thus he could observe and compare the action of the different points. In this case the phosphorescence is constant and is manifested from any point of the nerve at a greater or less distance from the excited point. But while the action seems constant, it might be due to a series of impulses which are too short to be observed. Before the discovery of the N-rays he showed that all short electric excitations gave rise to oscillations in the nerve whose frequency is from 750 to 800 cycles per second and the wave-length is about 35 millimeters. The speed of transmission is that of the nerve flux.

He now shows that the N-rays undergo a similar oscillation. He uses two wires of equal length and connects them to the same phosphorescent screen. This gives two different courses of N-rays, coming from the sciatic nerve of a frog. In this case the screen does not become as bright as in the case with one wire alone. For certain well-defined intervals there is no more increase of brightness to be observed on the screen at the moment of exciting the nerve. But each one of the wires taken separately gives an increase of illumination. This action can be explained if the N-rays produced by exciting the nerve are of a pulsatory character. This produces an interference effect in the two wires; and the brightness changes according to whether the waves in the wires arrive in or out of the phase with each other. If they advance or retard by half a wave-length, the effect will be neutralized, as in the case of light. The nerve may be excited either mechanically or electrically, but the latter is more convenient, in order to avoid destroying the tissue. The points A B of the two wires are taken at first near together, then further apart. M. Charpentier finds that the distance between the two points for which the excitation of the nerve does not produce any effect on the screen is 16 millimeters. This figure is just one-half the wave-length which he found before for oscillations of N-rays. He thus confirms the reality of these oscillations by the above interference phenomena.

THE GLACIER BEAR.

ONE of the most remarkable animals of Alaska is the glacier bear (*Ursus emmonsi*). This is of the black bear group, but unlike its congeners it is gray in color, a very unusual tint among bears, and probably found elsewhere only in the bears of the mountain ranges of Tibet. The animal lives among the snow fields and glaciers back of Mount St. Elias. Little is known of its habits, and but few specimens have ever reached museums. Indeed, the creature may well be considered among the rarest of American animals. Its existence was vaguely known to hunters and explorers for a long time, but the species was not definitely established until 1875. It was named in honor of Lieut. Emmons, of the United States army. For these particulars and illustration we are indebted to the report of the United States National Museum.

THE GLACIER BEAR.

According to the observation of M. Jean Becquerel, it appears that different bodies which give off N-rays are acted upon by anæsthetics and their activity is diminished. It has been previously shown that vegetable substances which give off the rays lose this property in great measure when acted upon by chloroform. It seems therefore to be a function of the nutritive action of the vegetable substances during their evolution. M. Becquerel finds that the effect of the anæsthetics may be also extended to inorganic bodies. Different sources of N-rays, such as calcium sulphide and insolated sand, have their activity suspended by the action of chloroform, ether, nitrogen peroxide, etc. To show this effect, he places a calcium sulphide screen in a flask having two tubulures. A current of air, charged with chloroform or not, can be sent through the flask. When the chloroform is passed, the screen becomes less luminous, but it recovers its strength when the chloroform is removed. To study the action more closely, he replaces the sulphide by other sources of N-rays and brings the latter to the exterior. It will be remembered that the rays can be conducted along a wire, but instead of a wire he prefers to use a truncated cone of copper to bring the rays to the outside. The cone is run through the cork of the flask with the large end inside and coated with calcium sulphide or other substance. The small end of the cone lying outside thus becomes a source of the rays and is quite intense, seeing that the rays are now concentrated upon a smaller surface. Under these conditions he

observes the following phenomena: First, chloroform alone does not give off the N-rays. Second, when the chloroform vapor is passed through the flask there is a short interval, one or two seconds, when the screen seems to be excited more strongly and the production of the rays is somewhat greater. Third, this period of excitation is followed by a gradual diminution of the rays down to a point where they disappear almost entirely. Fourth, on removing the chloroform, the energy of the screen returns, showing that the action has been only suspended, and not destroyed. Ether and nitrogen protoxide give the same effect in a less degree. According to these observations, the similarity of the action which is noticed in the case of inert and living matter shows the importance of finding out whether the role of anæsthetics upon living organisms is limited to modifying the emission of N-rays. If this can be demonstrated, it would seem to prove that the emission of these rays constitutes one of the primordial phenomena of vital activity.

ELECTRICAL NOTES.

In a paper lately read before the Academie des Sciences, M. C. Gutton shows that phosphorescence is increased by the action of the magnetic field. He used a cardboard screen covered with phosphorescent sulphide of calcium. When the screen is moved along a bar magnet the phosphorescence is seen to increase when near the poles, and diminish when the sulphide is near the center of the magnet. The N-rays, which might increase the phosphorescence, were eliminated by covering the magnet with lead foil. This action also takes place *in vacuo*, as is proved by passing a Crookes tube containing like substances over the magnet. A solenoid gives the same effect as a magnet if it is sufficiently short, but when it is long enough to create a uniform field in the interior, the action of such a field disappears. When the screen is in the center of the coil, the current can be made and broken without observing any difference in brilliancy. But if the sulphide is placed outside the coil in a region where the field is not uniform, the phosphorescence becomes more visible when the circuit is closed than on open circuit. Seeing that the field is stronger inside the coil, this shows that when the field is uniform it has no action and it is only a non-uniform field which produces it. The action is more strongly marked as the field is less uniform, and between the poles of a powerful Faraday magnet the effect on the sulphide is but slight, even though the field is intense. If the uniformity of the field is destroyed by placing an iron wire near the sulphide, the latter becomes brighter, and the same is true when the screen is moved out to a less uniform part of the field. The effect which was observed at first with the bar magnet is due to the fact that the field is not only stronger at the poles, but also more variable. For the same reason, the earth's magnetism has no action, but even here it can be observed if the uniformity is destroyed by placing pieces of iron wire near the screen. Other experiments give similar results and show that the action is due to a variable magnetic field.

A remarkable point in the action of the field upon phosphorescent bodies is the great sensitiveness of the latter. When the screen is brought near a bar of bismuth or a test tube containing a solution of ferric chloride, the very slight alterations of the earth's magnetic field which are thus brought about are sufficient to increase the brightness of the screen.* A very small current will produce a like effect. M. Gutton placed the sulphide at half an inch from a straight wire carrying a current, and the field is sufficient to produce the effect, even with one Daniell cell and a resistance of 100,000 ohms in the circuit. The magnetic field can be made to act upon the eye, and objects which are dimly lighted can be seen more distinctly. Pieces of white paper are observed in an obscure chamber, and these appear to become brighter when the magnet is brought near the eye. The N-rays have also this effect, but the magnet is wrapped in lead foil to cut them off. The same experiments may be repeated with solenoids. Attempts have been made heretofore to find whether a strong magnetic field had not an effect upon the human body, and Lord Lindsay and C. F. Varley made a magnet large enough to put the head between the poles, and it was expected that some perceptible effect would thus be felt. This was not the case, however. The above experiments, which are of a different character, show that the magnetic field has an effect in increasing the visual power.

Trunk railroads are experiencing severe competition from electric street surface railroads in the local and suburban traffic in Great Britain, with the result that their revenue from this source has been heavily decreased. With a view to cope with this rivalry, the Lancashire & Yorkshire Railroad has introduced a new compact train capable of rapid acceleration in speed, and quick stopping power. The train comprises a tank locomotive of powerful design, hauling four bogie carriages of a new type and great passenger-carrying capacity. The engine weighs seventy-eight tons, and is capable of developing a speed of thirty miles in thirty seconds. The coaches each seat six persons a side; and the four carriages provide accommodation for 322 passengers, as compared with the carrying capacity of 284 persons in seven coaches of the older type. The new carriage is one foot wider. A third-class coach contains nine compartments and is five feet longer. Its weight has been increased from twenty-two to twenty-four tons, and its seating capacity to 108 passengers. Eighty is all that an ordinary eight-compartment coach will hold. The trains are much shorter and easier to haul, which is essential in a hilly district.

* In all these experiments the effect of the N-rays is eliminated by screens of lead-foil.

ENGINEERING NOTES.

Petroleum cars have been run for some time on the state railways of Württemburg. The latest car is arranged to seat 44 passengers, which load it can take up grades of 1 per cent at a speed of 16 miles an hour. The motor has four cylinders, developing 30 horse-power. It is geared for four speeds, ranging from 4.5 to 22.5 miles per hour. Its weight empty is 12.5 tons, and it carries 100 kilogrammes of petroleum, which is sufficient for a run of 220 miles. Its first cost is $7,500, and the running expenses are 5.8 cents per car mile, of which 3.2 cents goes for petroleum. The car is used on secondary lines having a light traffic.

The Mallet compound locomotive now building at the works of the American Locomotive Company for the Baltimore and Ohio Railroad will in many ways be the most remarkable engine ever constructed. Its total weight will be over 300,000 pounds, all of which is on the driving wheels. It will replace two heavy consolidation locomotives in pushing service over a hilly and very crooked track, and will, it is expected, exert a tractive effort of 70,000 pounds when running as a compound. The boiler is of exceptional size, and measures 38 feet 5 inches in length from the front to the firebox door, and 88 inches in diameter. It weighs 117,000 pounds with water, but without the exterior fittings. The weight of the water alone is 33,000 pounds, and that of the tubes 27,000 pounds, the weight of the shell and firebox without tubes being 57,000 pounds. The working pressure is to be 235 pounds per square inch. The firebox is 108 inches long by 95 inches wide; 80 inches deep at the front end, and 72 inches at the back end. The boiler provides 5,372 square feet of heating surface in the tubes and 219 square feet in the firebox, making a total of 5,591 square feet. The grate area is 72¼ square feet.

A patent recently granted in the United States refers to a process for hardening and tempering cast iron in the rough or in the finished state. In this process the casting is first heated to a cherry-red heat. It is then dipped in a bath which consists of a practically anhydrous acid of high heat-condensing power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of one or more of the heavy metals or their compounds—such, for example, as arsenic or the like. The preferable ingredients of the bath are sulphuric acid of a specific gravity of approximately 1.84, and red arsenic in the proportion of ¾ pound of red arsenic crystals to 1 gallon of sulphuric acid. The castings may be either suddenly dipped in the aforementioned mixture, and then taken out and cooled in water, or they may be left in the bath until cool. In preparing the bath when sulphuric acid and red arsenic are used, the inventors find that better results are obtained when the crystals are added to the sulphuric acid, and the bath is allowed to stand for about a week before using. It is found that in castings of comparatively large dimensions the hardening extends completely through the material.

The report of the Turbine Commission appointed by the Cunard Company discusses at great length the whole question of the turbine engine. The machinery will have to develop about 70,000 indicated horse-power, and the mean will be 65,000. The turbine engines will be, it is estimated, about 300 tons less in weight than reciprocating engines. The mean speed is to be 24½ knots and 25 knots on a long trial trip. They advise four screw shafts, which will give a maximum of about 18,000 indicated horse-power on any one shaft. The revolutions will be 140 per minute. Parsons type of turbine is recommended. There will be one go-ahead turbine on each of the four shafts, which will be almost equidistant from each other. The high-pressure turbines will be mounted on two outside shafts—an arrangement which enables the shafts to be far from the center of the ship without interfering with the lines of the hull. These shafts will have the propellers at a considerable distance from the stern of the ship, so that there will be the minimum of disturbance to the flow of water to the two inside propellers, which will be placed right aft in the usual way. On each of the two inside shafts there will be two turbines. On each there will be the two low-pressure turbines for driving the ship ahead. The other two are for astern motion. The power for ahead motion is in two steam units, each with one high and one low-pressure turbine, giving the best expansion of steam; but should there be any breakdown of one shaft, turbine, or propeller, the three remaining shafts may be run, and thus only one-fourth of the power will be unavailable. Since the turbine can be overloaded to a very much greater extent than the reciprocating engines, it will be possible to reduce this proportion of lost power very considerably, so that with a fractured shaft the sea speed may not fall short of the normal rate by more than a mile or a mile-and-a-half per hour. Another advantage of the four screws and of the two central shafts being fitted with astern driving turbines is that the power for driving astern will be equal to about one-half the forward motive power distributed through two shafts. The possibility of an overloading of the turbines will add to the maneuvering qualities, and reduce the time and distance required for bringing the ship to a state of rest when running at full speed ahead. The commission recommend boilers of the cylindrical type, with forced draft. The coal consumption will exceed 1,000 tons per day. The length is fixed at 760 feet, the beam 88 feet. It is anticipated that a draft of 34 feet will be necessary when the vessel is laden with her coal supply for the voyage.

TRADE NOTES AND RECIPES.

Ridding Bottles of Persistent Odors.—Some odors in bottles have baffled almost all attempts of druggists to counteract or dissipate them. Iodoform, asafetida, ichthyol and valerian are among the articles which furnish these persistent odors. Fresh powdered mustard poured into the bottle (Sud. Apoth. Zeit.), followed by cold water, agitation, short standing and a final rinsing, will clear them of the offending odors.

Renovating Bronzes and Gilt Work.—For gilt work, first remove all grease, dirt, wax, etc., with a solution in water of potassium or sodium hydrate (Form. Indust. through Nat. Drug.), then dry, and with a soft rag apply the following:

Sodium carbonate	7 parts
Spanish whiting	15 parts
Alcohol, 85 per cent	50 parts
Water	125 parts

Go over every part carefully, using a brush to get into the minute crevices. When this dries on, brush off with a fine linen cloth or a supple chamois skin.

Or the following plan may be used: Remove grease, etc., as directed above, dry and go over the spots where the gilt surface is discolored, with a pencil dipped in a solution of 2 parts of alum in 250 parts of water carrying 65 parts of nitric acid. As soon as the gilding reappears or the surface becomes bright, wash off, dry, and dry in the direct sunlight.

Still another cleaner is made of nitric acid, 30 parts; aluminium sulphate, 4 parts; distilled or rain water, 125 parts. Clean of grease, etc., as above, and apply the solution with a camel's hair pencil. Rinse off and dry in sawdust. Finally, some articles are best cleaned by immersing in hot soap suds, and rubbing with a soft brush. Rinse in clear hot water, using a soft brush to get residual suds out of crevices. Let dry, then finish by rubbing the gilt spots or places with a soft linen rag, or a bit of chamois.

There are some bronzes gilt with imitation gold, and varnished. Where the gold is well done and the gilding has not been on too long, they will deceive even the practised eye. The deception, however, may easily be detected by touching a spot on the gilt surface with a glass rod dipped in a solution of corrosive sublimate. If the gilding is true no discoloration will occur, but if false a brown spot will be produced.—Druggists Circular.

Action of Various Soluble Substances When Mixed With Tempering Water.—It is well known that the addition of certain soluble substances powerfully affects the action of tempering water. This action is strengthened if the heat-conducting power of the water is raised by means of these substances; it is retarded if this power is reduced, or the boiling point substantially lowered. The substance most frequently used for the purpose of increasing the heat-conducting power of tempering water is common salt. This is dissolved in varying proportions of weight, a saturated solution being generally used as a quenching mixture. The use of this solution is always advisable when tools of complicated shape, for which a considerable degree of hardness is necessary, are to be tempered in large quantities or in frequent succession. In using these cooling fluids, care must be taken that a sufficient quantity is added to the water to prevent any great rise of temperature when the tempering process is protracted. For this reason the largest possible vessels should be used, wide and shallow, rather than narrow and deep vessels being selected. Carbonate of soda and sal ammoniac do not increase the tempering action to the same extent as common salt, and are therefore not so frequently employed, though they form excellent additions to tempering-water in certain cases. Tools of very complicated construction, such as fraises, where the danger of fracture of superficial parts has always to be kept in view, can with advantage be tempered in a solution of soda or sal ammoniac. Acids increase the action of tempering water considerably, and to a far greater extent than common salt. They are added in quantities up to two per cent, and frequently in combination with salts. Organic acids (e. g., acetic or citric) have a milder action than mineral acids (e. g., hydrochloric, nitric, or sulphuric). Acidulous water is employed in tempering tools for which the utmost degree of hardness is necessary, such as instruments for cutting exceptionally hard objects, or when a sufficiently hard surface has to be given to a kind of steel not capable of much hardening. Alcohol lowers the boiling point of water, and causes so vigorous an evaporation when the water comes in contact with the red-hot metal, that the tempering is greatly retarded (in proportion to the amount of alcohol in the mixture). Water containing a large quantity of alcohol will not temper. Soap and soap suds will not temper steel; this property is made use of in the rapid cooling of steel for which a great degree of hardness is not desirable. When certain parts of completely tempered steel have to be rendered soft, these parts are heated to a red heat and then cooled in soap suds. This is done with the tangs of files, knives, swords, saws, etc. Soluble organic substances retard the tempering process in proportion to the quantity used, and thus lessen the effect of pure water. Such substances (e. g., milk, sour beer, etc.) are employed only to a limited extent.—Der Metallarbeiter.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Apples in Germany.—Under the familiar headline "Another American Danger," the agrarian and conservative press in Germany is commenting somewhat demurely on the unprecedented influx of American apples this season and the extent to which they have filled and dominated all the more important markets in this country. There is not a fruit store or hardly a market fruit stall or retail grocery shop in Berlin or its suburbs that does not display as a prime attraction one or more barrels of Baldwins, Pippins, or other standard varieties, surmounted by a placard bearing the legend "Echte Amerikaner." Not only this, but wagons piled with the same attractive merchandise patrol the outlying streets and peddle the American fruit at the uncommonly low price of 20 pfennigs (5 cents) per pound. This, at a time when ordinary cooking apples grown in Germany and Austria retail for from 6 to 7 cents per pound, has furnished an object lessen of comparative cost, quality, and flavor as between the American and European fruit which can not be misunderstood or ignored. The dimensions to which this special import has grown will be indicated by the fact that only a few days ago the steamship "Main," of the North German Lloyd Line, landed at Bremen 22,929 barrels and 1,540 boxes of American apples, which is said to be the largest fruit cargo ever carried across the Atlantic in a single vessel.

From all accounts and the appearance of the American apples displayed here in markets and stores, they have generally arrived in excellent condition, showing not only that they are from a sound crop of good quality, but that American fruit growers and dealers have greatly improved their methods of picking and packing for export. The point is proven that, given a good sound apple crop in the United States, the standard varieties can be exported with entire safety in ordinary ventilated barrels without any of the elaborate and more or less costly paper wrappings that are used in putting up apples of choice quality from France, Italy, and the Tyrol. This, in view of the high cost of hand labor in America, is a point of great economic advantage, but it does not in the least modify the absolute necessity of careful hand picking, assorting, and putting while dry into barrels with such care that all bruising and contusions are avoided. Much is also doubtless due to shipping in properly cool and ventilated steamers, instead of the hot, stuffy holds of slow sailing ships, piled with other freight and with hatches battened down from port to port.

Position of the Press.—The general tenor of agrarian-press comment on the present Yankee-apple invasion is that it proves the inadequacy both of the German home-grown fruit supply and of the existing import-duty rate to protect the farmers of the Fatherland from this fatal competition. To this is usually added the fervent hope that these colossal importations will not result in filling the orchards of Germany with the San José scale.

The fear is gravely expressed that not even the German inspectors can scrutinize such cargoes of apples as are now coming with sufficient minuteness to prevent an occasional "Schildlaus" from escaping, and this, notwithstanding the assurance of German scientists that the San José scale can never thrive and reproduce in the climate of Germany, continues to inspire apprehension in certain quarters.

German Fruit Orchards.—The facts are simply that, with the exception of a few favored localities, Germany is, for climatic reasons, not well adapted to the growth of high-grade apples; that horticulturists here have been strangely negligent and have permitted their orchards in many cases to degenerate into groups of old trees bearing poor, natural fruit, tough in fiber and of indifferent flavor; that the superior, crisp tenderness and aromatic taste of the American apples, combined with cheapness of price, are now so well known and highly appreciated that their home market can never be reconquered, if at all, until new orchards of carefully-selected and grafted varieties can be grown and brought into bearing. Even then there will be seasons so humid and deficient in sunshine as to make the competition difficult for the German farmer.

Official statistics show that in 1900, Germany imported 124,874 tons of fresh apples; in 1901, 118,233 tons; and in 1902, 112,635 tons—of which the United States supplied 1,760 tons, 1,972 tons, and 5,835 tons, respectively. This year the American contribution will far surpass that of any previous season, but it will be after all only a small fraction—probably not more than 8 or 10 per cent—of the aggregate apple imports of Germany. There is, therefore, and will always be, abundant room for expansion in this branch of American exports to Germany. Not for a generation to come, if ever, can the native-grown supply be expanded and improved to meet the steadily growing demand. The advantages of superior quality and generally lower price, the heritages of a fertile soil and genial climate, will be permanently in favor of the American fruit. If the trade is vigorously pushed and judiciously managed, the tendency of our fresh-fruit exports will be to replace more and more the vast quantities of apples that are now imported from Switzerland, Austria, Holland, and Italy.—Frank H. Mason, Consul-General at Berlin, Germany.

American Trade with Southern Germany.—The last annual report of the chamber of commerce of the city and district of Mannheim, the great inland port of entry from which foreign goods are distributed to southern Germany and Switzerland, contains some noteworthy remarks on trade with the United States. Among these I quote the following:

"Iron and Steel Trade.—During 1902 domestic orders did not nearly suffice to employ Germany's iron and steel works. The exportation to the United States assumed large proportions, but brought little profit and in some cases even loss, nevertheless it helped to keep the works going and prevented large discharges of employes. The capability of the American market to take up our surplus of iron and steel appears to wane. The prospects for the future are made dismal by the threatening danger that our great customer, the United States, will in the near future enter the arena as a competitor.

"American Petroleum.—Since last spring the system of retailing petroleum by means of tank street wagons has been extended. We learn from impartial sources that this system is beneficial to the consumer and gives the retail dealer numerous advantages above the former mode of receiving the oil in barrels. The losses and abuses attending the latter are thus avoided, the oil is sold at a lower price, and the public is protected against the manipulations formerly practised by some of the petroleum dealers of mixing inferior oils with the American petroleum, leaving the consumers to believe they were getting the pure American product. True, the wholesale oil dealer to a certain degree is a loser by this tank system, but that can not be helped. Aside from this mode of selling the American oil, the importers of Russian and Roumanian petroleum have now introduced the tank street wagon system for the sale of their oils. The strong competition existing between these different oil-importing companies has lowered the price; therefore there is no ground for speaking of an oil monopoly.

"Rubber Goods.—A rubber goods manufacturer in this district says the business in his line is adversely affected by the strong competition made by American and Russian rubber goods.

"California Dried Fruits Vindicated.—The chamber, having been informed of various cases of police prohibitions against the sale of California dried fruits on account of these containing sulphuric acid, instituted inquiries among the dealers in the district and conclusively ascertained the fact that not a single case of injury from the consumption of such fruit has ever been known. In consideration of the vast importance which the sale and use of these fruits are to the Mannheim district, the chamber petitioned the Imperial Sanitary Bureau of Germany to act in the matter by fixing the amount of sulphuric acid allowable in dried fruits."—Simon W. Hanauer, Deputy Consul-General at Frankfort, Germany.

American Cotton-Seed Oil in Austria.—The imports of cotton-seed oil from the United States decreased from 161 metric tons in 1901 to 120.4 metric tons in 1902, in consequence of the great increase in price of this article. Cotton-seed oil is used extensively here as a table oil, but the prices at which it has been held during the past two years have placed it beyond the reach of the poorer classes and cheaper oils took its place to some extent.

The import duty on cotton-seed oil is $1.96 per 220 pounds. It is proposed by the government to increase this duty to $8.12 per 220 pounds, which would be absolutely prohibitive. The advocates of the proposed increase have always asserted that it is necessary for the building up of the home oil industry. It would, however be difficult to substantiate such a claim. Olive oil never has been and probably never can be produced in Austria-Hungary in sufficient quantities to supply the home demand for table oil, and its cheaper substitutes, such as rape-seed oil and sunflower-seed oil, are rejected even by many of the less fastidious as unfit for human consumption.

Attempts have been made to import the raw material and produce cotton-seed oil in Austria, but all such attempts have failed because the cotton seed suffers by the long sea voyage and the quality of oil produced therefrom is greatly inferior to the American product. Experiments made with Egyptian cotton seed, which does not seem to undergo chemical changes during the comparatively short journey from Egypt to Austria, have shown that it is not fit for the manufacture of edible oil.

Furthermore, it is not at all probable, if the cotton-seed-oil industry were undertaken here, that a profitable market could be found in Austria-Hungary for the oil cake, which is so important a by-product of the cotton-seed-oil industry, inasmuch as its yield constitutes from 85 to 90 per cent of the weight of the raw material. Serious doubts must therefore be expressed whether the proposed imposition of a prohibitive import duty on cotton-seed oil would in the long run accomplish its purpose.—Fredk. W. Hossfeld, Consul at Trieste, Austria.

German vs. American Commercial Agents.—The majority of United States manufacturers who are attempting to build up an export trade rely too much upon correspondence and the sending of catalogues, and these not always in the language of the country to which they are sent. In very rare cases agents are sent out, and most of these are not conversant with the foreign language required, and are usually too much pressed for time and consequently do not study foreign conditions as carefully as they should. They labor under the mistaken idea that it is their mission to educate the whole world to adopt the English language and American customs, patterns, etc. The German agent does the reverse. He, as a general rule, is a linguist; he adapts himself to the conditions he finds where he wants to sell; he is in no hurry, but in a methodical manner goes to work and carefully studies every detail and does not depart until he is satisfied that he has acquired as full knowledge of trade conditions as is possible.

This, in my opinion, based upon many years of observation in different countries, is the secret of German success in the markets of the world. It is to be hoped that our manufacturers will adopt similar methods and not rely upon correspondence, catalogues, etc., only, but send out intelligent, courteous, wide-awake agents who are experts in their line and who also have the command of the language of the country where they want to sell goods. A so-called "general agency" is of no value, for under existing business conditions it restrains and renders business difficult in all directions. —Richard Guenther, Consul-General, Frankfort, Germany.

American Water-Filtration Plants in Russia.—The American system of water filtration has been adopted in many of the cities of Russia. Owing to the turbidity of the large rivers in Russia, they are very objectionable as sources of supply for municipalities or for such manufacturing purposes as paper making, bleaching, dyeing, the making of chemicals, etc., unless the sedimentary matter carried in suspension is first removed. In 1898 the chief engineer of the Moscow waterworks was sent to the United States to investigate and report on the American system of rapid filtration. On his return to Russia experiments were undertaken which demonstrated that by the American system extremely turbid waters could be rendered bright and clear at a rate of filtration fifty times as fast, and with only about one-thirtieth of the space required under the old sand system, while from a sanitary standpoint the bacteria were reduced over 99 per cent. The lessons taught by these experiments at Moscow resulted in the installation of the American system at Moscow, Nizhni Novogorod, Tzaritzin, Ribinsk, Balashoff, Amavir, Vladimir, Simbirsk, and Tomolsk. In addition to these, American filters have been used for manufacturing purposes on a large scale at Kostroma, Yaroslav, Orehoro-Zoujere, Tver, and Moscow, and others of this description are now in use by the Russian government at its navy department in St. Petersburg. Formerly, all of the parts of these filters were made in the United States—the cypress-wood tanks in Boston and the machinery, valves, and brasswork in New York. Since the late advance in the duties on American ironwork, several of the heavier parts of the machinery are now being made in Russia by the Jewell Export Filter Company.—Thomas E. Heenan, Consul at Odessa, Russia.

Parcel Post and American Trade in Austria.—Under date of April 29, 1904, United States Consul F. W. Hossfeld, of Trieste, in reply to the Department circular "Markets for American Fruits," reports concerning the best means of increasing our fruit trade in Austria-Hungary. That portion of his report relative to packing fruit in 10-pound cases, which would bring them within the limit weight of the parcel post, applies equally well to many other articles now exported in large packages. The consul says:

I would suggest that some of our superior qualities of dried fruits be put up in 10-pound cases. Such cases could be sent by parcel post from Hamburg or Bremen (where the Austrians purchase their supplies of our dried fruits) to any part of the German Empire or of the Austro-Hungarian Monarchy at a total expense of only 12 cents, and this convenience would, in my opinion, result in increased trade. It is not improbable that the recent establishment by the Cunard Company of a line of passenger steamships between Trieste and New York will, by insuring prompt and regular delivery, enable some of our green fruits, especially our apples, to gain a market in southern Austria.

New Line of Steamers to Nicaragua.—The Nicaraguan government has granted a concession to Mr. Weinberger, of New Orleans, for the establishment of a new line of steamers, to run from New Orleans or any other port of the United States, carrying passengers and freight. The proposed schedule is one steamer each week for Bluefields, one every three weeks for Cape Gracias a Dios, and one every three weeks for San Juan del Norte and Monkey Point, as soon as that port is opened for commerce.—John Todd Hill, Consul, San Juan del Norte, Nicaragua.

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SCIENCE NOTES.

An interesting investigation now being carried on in Florida by the Bureau of Fisheries has for its object the discovery and development of methods by which the valuable sheepswool sponge may be cultivated artificially. The method which promises the most satisfactory results is that of using cuttings. Large sheepswool sponges are cut into small pieces, which are fastened to an insulated wire fixed in the water, so that the sponges are supported a few inches above the bottom. These small bits, placed at close intervals along the wire, soon heal and form an organic attachment to it, and very soon begin to grow. It is too soon to predict just what results will be, but the indications are so far very encouraging, and it is believed that the time is not far distant when the sponge fisheries of Florida will be vastly increased in productiveness and value.—Dr. Evermann in the National Geographic Magazine.

The German Oriental Society is publishing two interesting reports on excavations in Babylon and Egypt. The expedition in Mesopotamia has been working at Fara and Abu-Hatal, ancient sites of Babylonian civilization which flourished long before the time of Nebuchadnezzar. Numerous sarcophagi have been found there. These were, mostly of burned clay. The bodies were placed in them, wrapped in mats. Very seldom was a body found without some drinking utensils. In the same graves numerous little alabaster pots were discovered filled with paint. In some cases the pots were joined together to form a sort of palette. Many necklets of agate and mother-of-pearl were also found, and in one case the body was supplied with fishing hooks and other piscatorial appliances. The Egyptian excavations were conducted among the ruined graves of Abusir, chiefly among the graves of Greeks who settled in Egypt previous to the time of Alexander the Great. Here, too, alabaster vessels were found, these containing ointments, each being marked with the name of its particular unguent. In some graves quantities of food were found, and in nearly every case a pair of strong shoes and a walking-stick were inclosed. The Greeks had in their mouths a small silver coin for paying Charon, while the Egyptians had effigies of this oarsman.

M. O. Leighton, hydro-economic expert of the United States Geological Survey, has recently investigated three waters in Indiana and has found them to be magnetic, imparting magnetic power to needles, knife blades, etc. This controverts the majority of chemists and engineers, who are always skeptical on this subject. One of these waters is at Cartersburg Springs, Hendricks County; another is derived from a driven well at Lebanon, while the third is from a driven well at Fort Wayne. Experiments were made by Mr. Leighton at Cartersburg Springs. Knives and needles were carefully tested previous to reaching the springs and subsequent thereto. Before immersing in water no magnetic properties were present. After the knife had been immersed in the water for five minutes needles were readily held edge to point. Two needles immersed for two minutes were actually attached by the points and held for four minutes in the face of a strong breeze. The knife maintained its magnetic power thirty hours after immersion. These waters contain large proportions of carbon dioxide gas, which is slowly released upon exposure to the air. While the water retains this gas it continues to impart magnetic properties to steel, but as soon as the gas escapes a heavy precipitate forms on the bottom of the container consisting of magnetic oxide of iron. All magnetic properties are lost after this action takes place. The iron in solution is believed to be in the form of ferrous carbonate.

What is the age of the earth? In the remarkable address which he delivered in 1894 at the Oxford meeting of the British Association, the late Lord Salisbury dealt with the "prodigality of the ciphers" which geologists and biologists had put at the end of the earth's hypothetic life. But he remarked that the theories of these savants required at least all this elbow room. Now we have another theory to add to its many predecessors. If Prof. Rutherford, of New Zealand, whose paper, read before the Royal Institution, recently, has excited the widest interest, is right, the great heat which is known to exist in the earth's center is due to radium. We must, therefore, entirely reconstruct our ideas as to the age of our planet. Turning to Lord Kelvin, who was on the platform, Prof. Rutherford said that the earth was probably not more than 20,000,000 years old. Geologists, however, speak of many million more years, and at the time that he formulated his estimate of 100,000,000 years Lord Kelvin made his reservation—"unless some new source of energy were discovered." Prof. Rutherford's idea is that in radium this new source has been found. According to Prof. Rutherford's theory, if the internal heat is due to the presence of radium, the gradual cooling down of the earth will be indefinitely postponed, and that scientific fear of a time when the heat of the sun shall have so far diminished that this earth will have ceased to be capable of supporting life in consequence of the intense cold is postponed for many millions of years, for the probability is that the heat of the sun is also due not to combustion, as was at one time supposed, but to unceasing radio-activity. Here, indeed, is food for thought, but, as Lord Goschen said at the Royal Society's dinner, science of itself can never diminish interest in the mysteries of the soul and human heart and the progress of the study of the humanities.

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